

SECTION 02076

REMOVING EXISTING PAVEMENTS AND STRUCTURES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Removing concrete paving, asphaltic concrete pavement, and base courses.
- B. Removing concrete curbs, concrete curb and gutters, sidewalks and driveways.
- C. Removing pipe culverts and sewers.
- D. Removing miscellaneous structures of concrete, masonry, or combination of concrete and masonry.

1.2 MEASUREMENTS AND PAYMENT

- A. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for disposal of debris.
- B. Coordinate removal work with utility companies.

PART 2 –PRODUCTS - Not Used

PART 3 – EXECUTION

3.1 PREPARATION

- A. Obtain advance approval from Owner for dimensions and limits of removal work.
- B. Identify known utilities below grade. Stake and flag locations.

3.2 PROTECTION

- A. Protect utilities that remain from damage.
- B. Protect trees and other plant growth, and features designated to remain.
- C. Protect adjacent public and private property from damage.
- D. Protect benchmarks, monuments, and existing structures designated to remain, from damage or displacement.

3.3 REMOVALS

- A. Remove by methods that will not damage underground utilities. Do not use a drop hammer near existing underground utilities.
- B. Minimize amount of earth loaded during removal operations.
- C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut minimum depth of 2 inches.
- D. Where street and driveway saw cut locations coincide or fall within three feet of existing construction or expansion joints, breakout to existing joint.
- E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.

3.4 DISPOSAL

- A. Inlet frames, grates, and plates; and manhole frames and covers, may remain Owner property. Disposal shall be in an appropriate manner.
- B. Remove debris resulting from Work under this section from site in an appropriate manner.

END OF SECTION

SECTION 02102

Clearing and Grubbing

PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK

- A. Clearing and grubbing on project site of trees, stumps, brush, roots, vegetation, logs rubbish and other objectionable matter within limits described in specifications or as shown on plans.
- B. Cleaning and grubbing shall be in advance of grading operation except that in cuts over 3 feet in depth, grubbing may be done simultaneously with excavation, provided objectionable matter is removed as specified.
- C. Dispose of all debris resulting from clearing and grubbing work.

1.02 PROTECTION OF ADJACENT WORK:

- A. Protect all areas outside indicated construction areas.
- B. Protect existing improvements, adjacent property, utilities and other facilities, and trees and plants not to be removed from injury or damage.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Provide materials required to perform work as specified.

PART 3 - EXECUTION

3.01 CLEARING:

- A. Clear all areas covered by dikes, roads, structures and embankments within project limits unless otherwise shown in plans.
- B. Remove all saplings, brush, down-timber and debris unless shown or directed otherwise.
- C. Use tree wound paint to treat scars, gashes or limbs stubs on trees not removed.

3.02 GRUBBING:

- A. Trees, stumps, root systems, rocks and other obstructions shall be removed to the depths shown when they fall within the construction templates for the following items:
 - 1. Footings 18-inches below bottom of footing.
 - 2. Sidewalks (or other types of walks) 12-inches below bottom of walk.
 - 3. Roadways or Streets 18-inches below bottom of subgrade
 - 4. Parking Areas 18-inches below bottom of subgrade
 - 5. Grassed Areas 18-inches below top soil
 - 6. Fills 24-inches below bottom of fill
- B. Blasting not permitted.

3.03 REMOVAL OF DEBRIS AND CLEANUP

- A. Burning is not permitted.
- B. Dispose of all waste materials not burned by removal from site.
- C. Materials cleared and grubbed shall be the property of the Contractor and shall be his responsibility for disposal.

PART 4 - MEASUREMENT AND PAYMENT

4.01 CLEARING AND GRUBBING:

- A. Clearing and Grubbing shall be measured for payment either in acres or by lump sum only for areas indicated on the plans, or as provided in the proposal and contract.
- B. When not listed as separate contract pay item, Clearing and Grubbing shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided in the proposal contract.
- C. Compensation, whether by contract pay item or incidental work will be for furnishing all materials, labor equipment, tools and in incidentals required for the work, all in accordance with the plans and these specifications.
- D. Refer to Section 01200 – Measurement and Payment, for unit price procedures.

END OF SECTION

SECTION 02316

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Excavation, backfilling, and compaction of backfill for structures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - I. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to the required density due to either gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.
- C. Select Material: Material as defined in Section 02320 - Utility Backfill Materials.
- D. Backfill: Select material meeting specified quality requirements, placed and compacted under controlled conditions around structures.
- E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for the structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- F. Foundation Base: For foundation base material, use crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. The foundation base provides a smooth, level working surface for the construction of the concrete foundation.
- G. Foundation Subgrade: Foundation subgrade is the surface of the natural soil which has been excavated and prepared to support the foundation base or foundation backfill, where needed.

- H. Ground Water Control Systems: Installations external to the excavation such as well points, eductors, or deep wells. Ground water control includes dewatering to lower the ground water, intercepting seepage which would otherwise emerge from the side or bottom of the excavation, and depressurization to prevent failure or heaving of the excavation bottom.
- I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from the excavation. Remove rain water and surface water which accidentally enters the excavation as a part of excavation drainage.
- J. Excavation Drainage: Removal of surface and seepage water in the excavation by sump pumping and using French drains surrounding the foundation to intercept the water.
- K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below the foundation as shown on Drawings, and backfilled with foundation backfill material.
- L. Shoring System: A structure that supports the sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.4 REFERENCES

- A. ASTM D 558 - Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
- B. ASTM D 698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.88-mm) Drop.
- C. ASTM D 1556 - Density of Soil in Place by the Sand-Cone Method.
- D. ASTM D 2487 - Classification of Soils for Engineering Purposes.
- E. ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ASTM D 3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).
- G. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- H. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- I. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.
- J. Federal Regulations, 29 CFR, Part 1926, Standards - Excavation, Occupational Safety and Health Administration (OSHA).

1.5 SUBMITTALS

- A. Conform to requirements of Section 01300 - Submittal Procedures.
- B. Submit a work plan for excavation and backfill for each structure with complete written description which identifies details of the proposed method of construction and the sequence of operations for construction relative to excavation and backfill activities. The descriptions, with supporting illustrations,

shall be sufficiently detailed to demonstrate to the Owner that the procedures meet the requirements of the Specifications and Drawings.

C. Submit excavation safety system plan.

1. The excavation safety system plan shall be in accordance with applicable OSHA requirements for all excavations.
2. The excavation safety system plan shall be in accordance with the requirements of Section 01561 - Trench Safety System, for all excavations that fall under State and Federal trench safety laws.

D. Submit a ground and surface water control plan in accordance with requirements in this Section and Section 01563 - Control of Ground Water and Surface Water.

E. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

F. Submit project record documents under provisions of Section 01720 - Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.6 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by the Owner in accordance with requirements of Section 01410 - Testing Laboratory Services and as specified in this Section.
- B. Contractor shall perform embedment and backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

PART 2 –PRODUCTS

2.1 EQUIPMENT

- A. Perform excavation with equipment suitable for achieving the requirements of this Specification.
- B. Use equipment which will produce the degree of compaction specified. Backfill within 3 feet of walls shall be compacted with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to the depth of the fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.2 MATERIAL CLASSIFICATIONS

- A. Backfill materials shall conform to the classifications and product descriptions of Section 02320 - Utility Backfill Materials. The classification or product description for backfill applications shall be as shown on the Drawings and as specified.

PART 3 –EXECUTION

3.1 PREPARATION

- A. Conduct an inspection to determine condition of existing structures and other permanent installations.
- B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Maintain barricades and warning devices at all times for streets and intersections where work is in progress, or where affected by the Work, and is considered hazardous to traffic movements.
- C. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 01561 - Trench Safety Systems.
- D. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02076 - Removing Existing Pavements and Structures.
- E. Install and operate necessary dewatering and surface water control measures.

3.2 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within the grading limits as designated on the Drawings.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities are indicated on the Drawings.
- D. Prevent erosion of excavations and backfill. Do not allow water to pond in excavations.
- E. Maintain excavation and backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density at no additional cost to the Owner.

3.3 EXCAVATION

- A. Perform excavation work so that the underground structure can be installed to depths and alignments shown on Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to the absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Owner.
- B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Owner and obtain instructions before proceeding in such areas.
- C. Immediately notify the agency or company owning any line which is damaged, broken or disturbed. Obtain approval from Owner and agency for any repairs or relocations, either temporary or permanent.
- D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.
- E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.
- F. Conduct hauling operations so that trucks and other vehicles do not create a dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud, or other materials that spill onto streets or are deposited onto streets by vehicle tires.
- G. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by the Work.

- H. Provide sheeting, shoring, and bracing where required to safely complete the Work, to prevent excavation from extending beyond limits indicated on Drawings, and to protect the Work and adjacent structures or improvements. Sheeting, shoring, and bracing used to protect workmen and the public shall conform to requirements of Section 01561 - Trench Safety Systems.
- I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, concrete fill, cement stabilized sand, or other material approved by Owner.
- J. After completion of the structure, remove sheeting, shoring, and bracing unless shown on Drawings to remain in place or directed by Owner in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to the Work and adjacent structures or improvements.
- K. Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or material approved by Owner.

3.4 HANDLING EXCAVATED MATERIALS

- A. Classify excavated materials. Place material which is suitable for use as backfill in orderly piles at a sufficient distance from excavation to prevent slides or cave-ins.
- B. Provide additional backfill material in accordance with requirements of Section 02319 - Borrow, if adequate quantities of suitable material are not available from excavation and trenching operations at the site.

3.5 DEWATERING

- A. Provide ground water control per Section 01563 - Control of Ground Water and Surface Water.
- B. Keep ground water surface elevation a minimum of 2 feet below the bottom of the foundation base.
- C. Maintain ground water control as directed by Section 01563 - Control of Ground Water and Surface Water and until the structure is sufficiently complete to provide the required weight to resist hydrostatic uplift with a minimum safety factor of 1.2.

3.6 FOUNDATION EXCAVATION

- A. Notify Owner at least 48 hours prior to planned completion of foundation excavations. Do not place the foundation base until the excavation is accepted by the Owner.
- B. Excavate to elevations shown on Drawings, as needed to provide space for the foundation base, forming a level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or a material as directed by the Owner. Prior to placing material over it, recompact the subgrade where indicated on the Drawings, scarifying as needed, to 95 percent of the maximum Standard Dry Density according to ASTM D 698. If the specified level of compaction cannot be achieved, moisture condition the subgrade and recompact until 95 percent is achieved, over-excavate to provide a minimum layer of 24 inches of foundation backfill material, or other means acceptable to the Owner.
- C. Fill unauthorized excessive excavation with foundation backfill material or other material as directed by the Owner.
- D. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in a satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.

- E. Soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to the required subgrade, shall be removed and replaced with foundation backfill material, as directed by Owner, at no additional cost to the Owner.
- F. Place foundation base, or foundation backfill material where needed, over the subgrade on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with a seal slab or cement-stabilized sand.
- G. Crushed aggregate, and other free draining Class I materials, shall have a filter fabric as specified in Section 02621 - Geotextile, separating it from native soils or select material backfill. The fabric shall overlap a minimum of 12 inches beyond where another material stops contact with the soil.
- H. Crushed aggregate, and other Class I materials, shall be placed in uniform layers of 8-inch maximum thickness. Compaction shall be by means of at least two passes of a vibratory compactor.

3.7 FOUNDATION BASE

- A. After the subgrade is properly prepared, including the placement of foundation backfill where needed, the foundation base shall be placed. The foundation base shall consist of a 12-inch layer of crushed stone aggregate or cement stabilized sand. Alternately, a seal slab with a minimum thickness of 4 inches may be placed. The foundation base shall extend a minimum of 12 inches beyond the edge of the structure foundation, unless shown otherwise on the Drawings.
- B. Where the foundation base and foundation backfill are of the same material, both can be placed in one operation.

3.8 BACKFILL

- A. Complete backfill to surface of natural ground or to lines and grades shown on Drawings. Use existing material that qualifies as select material, unless indicated otherwise. Deposit backfill in uniform layers and compact each layer as specified.
- B. Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that the concrete has reached a minimum of 85 percent of the specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill operations until the slab or intermediate walls have been placed and concrete has attained sufficient strength.
- C. Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.
- D. Maintain fill material at no less than 2 percent below nor more than 2 percent above optimum moisture content. Place fill material in uniform 8-inch maximum loose layers. Compaction of fill shall be to at least 95 percent of the maximum Standard Dry Density according to ASTM D 698 under paved areas. Compact to at least 90 percent around structures below unpaved areas.
- E. Where backfill is placed against a sloped excavation surface, run compaction equipment across the boundary of the cut slope and backfill to form a compacted slope surface for placement of the next layer of backfill.
- F. Place backfill using cement stabilized sand in accordance with Section 02321 - Cement Stabilized Sand.

3.9 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01410 - Testing Laboratory Services.
- B. Tests will be performed initially on minimum of one different sample of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

- C. In-place density tests of compacted subgrade and backfill will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions:
 - 1. A minimum of one test for every 100 cubic yards of compacted backfill material.
 - 2. A minimum of three density tests for each full work shift.
 - 3. Density tests will be performed in all placement areas.
 - 4. The number of tests will be increased if inspection determines that soil types or moisture contents are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density.
- D. At least one test for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- E. If tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess materials in an appropriate manner.

END OF SECTION

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SECTION 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at the trench subgrade after excavation to depth of bottom of the bedding as shown on the Drawings, or foundation backfill material placed and compacted in over-excavations.
- B. Pipe Bedding: The portion of trench backfill that extends vertically from top of foundation up to a level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: The material placed on either side of pipe from top of bedding up to spring line of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: The portion of trench backfill that extends vertically from spring line of pipe (top of haunching) up to a level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: The portion of trench backfill that consists of bedding, haunching and initial backfill.
- F. Trench Zone: The portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to either gradation, plasticity, or moisture content.

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3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement are considered suitable, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements, placed and compacted under controlled conditions.
- J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage, which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom.
- K. Surface Water Control: Diversion and drainage of surface water runoff and rainwater away from trench excavation. Rainwater and surface water accidentally entering trench shall be controlled and removed as a part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using a drainage layer, as defined in ASTM D 2321, placed on the foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to the stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as a result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in the embedment zone in combination with ground water control in predominately sandy or silty soils.
 3. Unstable Trench: Unstable trench conditions exist in the pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

- N. Subtrench: Subtrench is a special case of benched excavation. Subtrench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of a subtrench depends upon trench stability and safety as determined by the Contractor.
- O. Trench Dam: A placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along the trench.
- P. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation backfill material.
- Q. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.
- R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 01561 - Trench Safety Systems.
- S. Trench Shield (Trench Box): A portable worker safety structure moved along the trench as work proceeds, used as a protective system and designed to withstand forces imposed on it by cave-in, thereby protecting persons within the trench. Trench shields may be stacked if so designed or placed in a series depending on depth and length of excavation to be protected.
- T. Shoring System: A structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of the ground affecting adjacent installations or improvements.
- U. Special Shoring: A shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on the Drawings.

1.4 REFERENCES

- A. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- B. ASTM D 558 - Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
- C. ASTM D 698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.8-mm) Drop.
- D. ASTM D 1556 - Test Method for Density in Place by the Sand-Cone Method.
- E. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- F. ASTM D 2487 - Classification of Soils for Engineering Purposes.
- G. ASTM D 2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

- H. ASTM D 3017 - Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- I. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- J. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- K. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.
- L. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

1.5 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on the same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

1.6 SUBMITTALS

- A. Conform to Section 01300 - Submittal Procedures.
- B. Submit a written description for information only of the planned typical method of excavation, backfill placement and compaction, including:
 - 1. Sequence of work and coordination of activities.
 - 2. Selected trench widths.
 - 3. Procedures for foundation and embedment placement, and compaction.
 - 4. Procedure for use of trench boxes and other pre-manufactured systems while assuring specified compaction against undisturbed soil.
 - 5. Procedure for installation of Special Shoring at locations identified on the Drawings.
- C. Submit a ground and surface water control plan.
- D. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.
- E. Submit a trench excavation safety program in accordance with requirements of Section 01561 - Trench Safety System. Include designs for special shoring meeting the requirements defined in Paragraph 1.08, Special Shoring Design Requirements.
- F. Submit record of location of utilities as installed, referenced to control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

1.7 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by the Contractor in accordance with requirements of Section 01410 - Testing Laboratory Services and as specified in this Section.
- B. Perform backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

1.8 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by the Contractor's Professional Engineer to provide support for the sides of the excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a pre-manufactured system selected by the Contractor's Professional Engineer to meet the project site requirements based on the manufacturer's standard design.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving the requirements of this Section.
- B. Use only hand-operated tamping equipment until a minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems, which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.
- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.8 - Shoring Design Requirements.

2.2 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials.
- B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.
- C. Geotextile (Filter Fabric).
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.
- E. Timber Shoring Left in Place: Untreated oak.

PART 3 - EXECUTION

3.1 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between the standard practice and the requirements of this Section, this Section governs.
- B. Install rigid pipe to conform with standard practice described in ASTM C 12, and as described in this Section. Where an apparent conflict occurs between the standard practice and the requirements of this Section, this Section governs.

3.2 PREPARATION

- A. Establish traffic control. Maintain barricades and warning lights for streets and intersections affected by the Work, and is considered hazardous to traffic movements.
- B. Perform work to conform with applicable safety standards and regulations. Employ a trench safety system as specified in Section 01900 - Trench Safety Systems.
- C. Immediately notify the agency or company owning any existing utility line, which is damaged, broken, or disturbed. Obtain approval from the Owner and agency for any repairs or relocations, either temporary or permanent.
- D. Install and operate necessary dewatering and surface water control measures.
- E. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those, which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.3 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within the grading limits as designated on the Drawings.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on the Drawings.
- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, recompact, and pave those areas at no additional cost to Owner.

3.4 EXCAVATION

- A. Except as otherwise specified or shown on the Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on the Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using the following schedule as related to pipe outside diameter (O.D.). Maximum trench width shall be the minimum trench width plus 24 inches.

Nominal
Pipe Size, Inches

Minimum Trench

Width, Inches

Less than 18

O.D. + 18

- D. Use sufficient trench width or benches above the embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from the surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify the Owner and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
1. Install Special Shoring in advance of trench excavation or simultaneously with the trench excavation, so that the soils within the full height of the trench excavation walls will remain laterally supported at all times.
 2. For all types of shoring, support trench walls in the pipe embedment zone throughout the installation. Provide trench wall supports sufficiently tight to prevent washing the trench wall soil out from behind the trench wall support.
 3. Unless otherwise directed by the Owner, leave sheeting driven into or below the pipe embedment zone in place to preclude loss of support of foundation and embedment materials. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and the trench wall in the vicinity of the pipe zone.
 4. Employ special methods for maintaining the integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 5. If sheeting or other shoring is used below top of the pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into the embedment zone shall be the equivalent of a 1-inch-thick steel plate. Fill voids left on removal of supports with compacted backfill material.
- G. Use of Trench Shields. When a trench shield (trench box) is used as a worker safety device, the following requirements apply:
1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to the trench sidewalls.
 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor the degree of compaction reduced.
 3. When required, place, spread, and compact pipe foundation and bedding materials beneath the shield. For backfill above bedding, lift the shield as

each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.

4. Maintain trench shield in position to allow sampling and testing to be performed in a safe manner.

3.5 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials, which are suitable as defined in this Section and conforming with Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at a distance from the trench to prevent slides or cave-ins.
- B. When required, provide additional backfill material conforming with requirements of Section 02320 - Utility Backfill Materials.
- C. Do not place stockpiles of excess excavated materials on roads. Protect excess stockpiles for use on site. Maintain site conditions.

3.6 GROUND WATER CONTROL

- A. Implement ground water control. Provide a stable trench to allow installation in accordance with the Specifications.

3.7 TRENCH FOUNDATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

3.8 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

- A. Immediately prior to placement of embedment materials, the bottoms and sidewalls of trenches shall be free of loose, sloughing, caving, or otherwise unsuitable soil.
- B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.
- C. For pipe installation, manually spread embedment materials around the pipe to provide uniform bearing and side support when compacted. Do not allow materials to free-fall from heights greater than 24 inches above top of pipe. Perform placement and compaction directly against the undisturbed soils in the trench sidewalls, or against sheeting which is to remain in place.
- D. Do not place trench shields or shoring within height of the embedment zone unless means to maintain the density of compacted embedment material are used. If moveable supports are used in embedment zone, lift the supports incrementally to allow placement and compaction of the material against undisturbed soil.
- E. Place geotextile to prevent particle migration from the in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
- G. Place haunching material manually around the pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight

pipe in place during compaction of haunch areas and placement beside the pipe with sand bags or other suitable means.

- H. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- I. For irrigation lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. For irrigation lines adhere to the following subparagraph numbers 1 and 2; for utility installation other than water, adhere to numbers 3 and 4 below:
 - 1. Class I, II, and III Embedment Materials:
 - a. Maximum 6 inches compacted lift thickness.
 - b. Compact to achieve a minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Owner.
 - 2. Cement Stabilized Sand:
 - a. Maximum 6 inches compacted thickness.
 - b. Compact to achieve a minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.
 - 3. Class I embedment materials.
 - a. Maximum 6-inches compacted lift thickness.
 - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed the pipe to meet the deflection test criteria.
 - c. Moisture content as determined by Contractor for effective compaction without softening the soil of trench bottom, foundation or trench walls.
 - 4. Class II embedment and cement stabilized sand.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by methods determined by Contractor to achieve a minimum of 95 percent of the maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.

- c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on the dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.
- J. Place trench dams in Class I embedments in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions.

3.9 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction.
- B. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave the sheeting in place. Cut off sheeting 1.5 feet or more above the crown of the pipe. Remove trench supports within 5 feet from the ground surface.
- C. For sewer pipes, use backfill materials described here as determined by trench limits. Uniformly backfill trenches partially within limits one foot from roads. Use select backfill within one foot below roads.
- D. For irrigation lines, backfill in trench zone with bank run sand, select fill, or random backfill material as specified in Section 02320 - Utility Backfill materials.
- E. When shown on Drawings, a random backfill of suitable material may be used in trench zone for trench excavations outside pavements.
- F. Place trench zone backfill in lifts and compact by methods selected by the Contractor. Fully compact each lift before placement of the next lift.
 - 1. Bank run sand.
 - a. Maximum 9-inches compacted lift thickness.
 - b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
 - c. Moisture content within 3 percent of optimum determined according to ASTM D 698
 - 2. Cement-stabilized sand.
 - a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but not exceeding 24 inches.
 - b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 558.
 - c. Moisture content on the dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Select fill.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by equipment providing tamping or kneading impact to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
 - c. Moisture content within 2 percent of optimum determined according to ASTM D 698.
- G. For trench excavations outside roads, a random backfill of suitable material may be used in the trench zone.
 1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. If the required density is not achieved, the Contractor, at his option and at no additional cost to the Owner, may use lime stabilization to achieve compaction requirements or use a different suitable material.
 2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 3. Compact to a minimum of 90 percent of the maximum dry density determined according to ASTM D 698.
 4. Moisture content as necessary to achieve density.

3.10 MANHOLES, JUNCTION BOXES, AND OTHER PIPELINE STRUCTURES

- A. Meet the requirements of adjoining utility installations for backfill of irrigation structures, as shown on the Drawings.

3.11 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.
- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to Owner.
- C. Tests will be performed on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions.

1. A minimum of one test for every 50 cubic yards of compacted embedment and for every 100 cubic yards of compacted trench zone backfill material.
 2. A minimum of three density tests for each full shift of Work.
 3. Density tests will be distributed among the placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
 4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
 5. Density tests may be performed at various depths below the fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 6. Two verification tests will be performed adjacent to in-place tests showing density less than the acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
 7. Recompact placement will be retested at the same frequency as the first test series, including verification tests.
- F. Recondition, recompact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction will be determined by inspection.

3.12 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess materials as directed by the Owner.

END OF SECTION

SECTION 02320

UTILITY BACKFILL MATERIALS

PART 1 – G E N E R A L

1.1 SECTION INCLUDES

- A. Material Classifications.
- B. Utility Backfill Materials:
 - Concrete sand
 - Gem sand
 - Pea gravel
 - Crushed stone
 - Crushed concrete
 - Bank run sand
 - Select backfill
 - Random backfill
- C. Material Handling and Quality Control Requirements.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to the required density due to either gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, and stones greater than 4 inches in any dimension; debris, vegetation, and waste; or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are the following:
 - 1. Those meeting specification requirements.
 - 2. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement.

- C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for the structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. The foundation base provides a smooth, level-working surface for the construction of the concrete foundation.
- E. Backfill Material: Classified soil material meeting specified quality requirements for the designated application as embedment or trench zone backfill.
- F. Embedment Material: Soil material placed under controlled conditions within the embedment zone extending vertically upward from top of foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching, and initial backfill.
- G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in the trench zone from top of embedment zone to base course in paved areas or to the surface grading material in unpaved areas.
- H. Foundation: Either suitable soil of the trench bottom, or material placed as backfill of over-excavation for removal and replacement of unsuitable or otherwise unstable soils.
- I. Source: A source selected by the Contractor for supply of embedment or trench zone backfill material. A selected source may be the project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.
- J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.4 REFERENCES

- A. ASTM C 33 - Specification for Concrete Aggregate.
- B. ASTM C 40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 123 - Test Method for Lightweight Pieces in Aggregate.
- D. ASTM C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- E. ASTM C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM C 142 - Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM D 1140 - Test Method for Amount of Materials in Soils Finer Than No. 200 Sieve.
- H. ASTM D 2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).

- I. ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
- J. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- K. ASTM D 4643 - Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
- L. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- M. TxDOT Tex-104-E - Test Method for Determination of Liquid Limit of Soils (Part 1)
- N. TxDOT Tex-106-E - Test Method - Methods of Calculating Plasticity Index of Soils.
- O. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01300 - Submittal Procedures.
- B. Submit a description of source, material classification and product description, production method, and application of backfill materials.
- C. Submit test results for samples of off-site backfill materials to comply with Paragraph 2.03, Materials Testing.
- D. Before stockpiling materials, submit a copy of temporary easement or approval from landowner for stockpiling backfill material on private property.
- E. For each delivery of material, provide a delivery ticket, which includes source location.

1.6 TESTS

- A. Perform tests of sources for backfill material in accordance with Paragraph 2.3B.
- B. Verification tests of backfill materials may be performed by the Owner in accordance with Section 01410 - Testing Laboratory Services.
- C. Random fill obtained from the project excavation as source is exempt from pre-qualification requirements by Contractor but may be inspected by Owner testing lab for unacceptable materials based on ASTM D 2488.

PART 2 – PRODUCTS

2.1 MATERIAL CLASSIFICATIONS

- A. Materials for backfill shall be classified for the purpose of quality control in accordance with the Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.
- B. Class Designations Based on Laboratory Testing:

1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
 - a. Plasticity index: non-plastic.
 - b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines:
 - a. Plasticity index: non-plastic to 4.
 - b. Gradations:
 - 1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
 - 2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
 - 3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
 - a. Plasticity index: greater than 7.
 - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
4. Class IVA: Lean clays (CL).
 - a. Plasticity Indexes:
 - 1) Plasticity index: greater than 7, and above A line.
 - 2) Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
 - b. Liquid limit: less than 50.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
5. Class IVB: Fat clays (CH)
 - a. Plasticity index: above A line.
 - b. Liquid limit: 50 or greater.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to the more restrictive class.

2.2 PRODUCT DESCRIPTIONS

- A. Soils classified as silt (ML), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as approved by the Owner. Soils in Class IVB, fat clay (CH) may be used as backfill materials where

allowed by the applicable backfill installation specification. Refer to Section 02317 - Excavation and Backfill for Utilities.

- B. Provide backfill material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to the following limits for deleterious materials:
1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
 2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
 3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.
- C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in the product specification, and approved by Owner, provided that the physical property criteria are determined to be satisfactory by testing.
- D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by the Unified Soil Classification System (ASTM D 2487) meeting the following requirements:
1. Less than 15 percent passing the number 200 sieve when tested in accordance with ASTM D 1140. The amount of clay lumps or balls not exceeding 2 percent.
 2. Material passing the number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318:
 - a. Liquid limit: not exceeding 25 percent.
 - b. Plasticity index: not exceeding 7.
- E. Concrete Sand: Natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to the requirements of ASTM C 33 and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- F. Gem Sand: Sand conforming to the requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- G. Pea Gravel: Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

- H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:
1. Materials of one product delivered for the same construction activity from a single source.
 2. Non-plastic fines.
 3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
 4. Crushed aggregate shall have a minimum of 90 percent of the particles retained on the No. 4 sieve with 2 or more crushed faces as determined by Test Method Tex-460-A, Part I.
 5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from a naturally occurring single source. Uncrushed gravel is not acceptable material for embedment where crushed stone is shown on the applicable utility embedment drawing details.
 6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are the same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.

7. Gradations, as determined in accordance with Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

- I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with a plasticity index between 8 and 20 or clayey soils treated with lime. Apply so that dry backfill will contain a minimum lime content of 5 percent by weight of dry backfill unless otherwise directed as a result testing to meet plasticity criteria.
- J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) where allowed by the applicable backfill installation specification. Refer to Section 02317 - Excavation and Backfill for Utilities.
- K. Concrete Backfill: Conform to Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

2.3 MATERIAL TESTING

- A. Ensure that material selected, produced and delivered to the project meets applicable specifications and is of sufficient uniform properties to allow practical construction and quality control.
- B. Source or Supplier Qualification. Perform testing, or obtain representative tests by suppliers, for selection of material sources and products. Provide test results for a minimum of three samples for each source and material type. Tests samples of processed materials from current production representing material to be delivered. Tests shall verify that the materials meet specification requirements. Repeat qualification test procedures each time the source characteristic changes or there is a planned change in source location or supplier. Qualification tests shall include, as applicable:
 1. Gradation. Complete sieve analyses shall be reported regardless of the specified control sieves. The range of sieves shall be from the largest particle through the No. 200 sieve.
 2. Plasticity of material passing the No. 40 sieve.
 3. Los Angeles abrasion wear of material retained on the No. 4 sieve.
 4. Clay lumps.
 5. Lightweight pieces

6. Organic impurities

- C. Testing Reports. Provide reports to the Owner from an independent testing laboratory that backfill materials to be placed in the Work meet applicable specification requirements.

PART 3 – EXECUTION

3.1 SOURCES

- A. Use of material encountered in the trench excavations is acceptable, provided applicable specification requirements are satisfied. If excavation material is not acceptable, provide from other approved source.
- B. Identify off-site sources for backfill materials at least 14 days ahead of intended use so that the Owner may obtain samples for verification testing.
- C. Obtain approval for each material source by the Owner before delivery is started. If sources previously approved do not produce uniform and satisfactory products, furnish materials from other approved sources. Materials may be subjected to inspection or additional verification testing after delivery. Materials, which do not meet the requirements of the specifications, will be rejected. Do not use material, which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination.
- D. Bank run sand, select backfill, and random backfill, if available in the project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete the work from off-site sources.
- E. The Owner does not represent or guarantee that any soil found in the excavation work will be suitable and acceptable as backfill material.

3.2 MATERIAL HANDLING

- A. When backfill material is obtained from either a commercial or non-commercial borrow pit, open the pit to expose the vertical faces of the various strata for identification and selection of approved material to be used. Excavate the selected material by vertical cuts extending through the exposed strata to achieve uniformity in the product.
- B. Establish temporary stockpile locations for practical material handling and control, and verification testing by the Owner in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
- C. When stockpiling backfill material near the project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering the drainage system.
- D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.3 FIELD QUALITY CONTROL

- A. Quality Control

1. The Owner may sample and test backfill at:
 - a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
 - b. On-site stockpiles.
 - c. Materials placed in the Work.
 2. The Owner may resample material at any stage of work or location if changes in characteristics are apparent.
- B. Production Verification Testing: The Owner's testing laboratory will provide verification testing on backfill materials, as directed by the Owner. Samples may be taken at the source or at the production plant, as applicable.

END OF SECTION

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SECTION 02321

CEMENT STABILIZED SAND

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Cement stabilized sand for backfill and bedding.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- B. ASTM C33 - Standard Specification for Concrete Aggregates (Fine Aggregate).
- C. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- D. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
- E. ASTM C123 - Standard Test Method for Lightweight Pieces in Aggregate.
- F. ASTM C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM C150 - Specification for Portland Cement.
- H. ASTM D558 - Standard Test Methods for Moisture-Density Relations of Soil-Cement Mixtures.
- I. ASTM D1632 - Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimen in the Laboratory.
- J. ASTM D1633 - Standard Test Method for Compressive Strength of Molded Soil- Cement Cylinders.
- K. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- L. ASTM D2901 - Standard Test Method for Cement Content of Freshly Mixed Soil-Cement.
- M. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.
- B. Submit material qualification and mix design tests to include:

1. Three series of tests of sand or fine aggregate material from the proposed source. Tests shall include procedures defined in Paragraph 2.1.
2. Three moisture-density relationship tests prepared using the material qualified by the tests of Paragraph 1.4B.1. Blends of fine aggregate from crushed concrete and bank run sand shall be tested at the ratio to be used for the mix design testing.
3. Mix design report to meet the design requirements of Paragraph 1.5. The mix design shall include compressive strength tests after 48-hours and 7 days curing.

1.5 DESIGN REQUIREMENTS

- A. Design sand-cement mixture to produce a minimum unconfined compressive strength of 100 pounds per square inch in 48 hours when compacted to 95 percent in accordance with ASTM D558 and when cured in accordance with ASTM D1632, and tested in accordance with ASTM D1633. Mix for general use shall contain a minimum of 1-1/2 sacks of cement per cubic yard. Mix for use as sanitary sewer embedment within 9 feet of waterlines shall contain 2 sacks of cement per cubic yard. Compact mix with a moisture content on the dry side of optimum.

PART 2 –PRODUCTS

2.1 MATERIALS

- A. Cement: Type 1 Portland cement conforming to ASTM C150.
- B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C33, or requirements for Bank Run Sand of Section 02317 - Utility Backfill Materials, and the following requirements:
 1. Classified as SW, SP or SM by the United Soil Classification System of ASTM D2487.
 2. Deleterious materials:
 - a. Clay lumps, ASTM C142; less than 0.5 percent.
 - b. Lightweight pieces, ASTM C123; less than 5.0 percent.
 - c. Organic impurities, ASTM C40; color no darker than the standard color.
 3. Plasticity index of 4 or less when tested in accordance with ASTM D4318.
- C. Fine aggregate manufactured from crushed concrete meeting the quality requirements for crushed rock material of Section 02317 - Utility Backfill Materials, may be used as a complete or partial substitute for bank run sand. The blending ratio of fine aggregate from crushed concrete and bank run sand shall be defined in the mix design report.
- D. Water: Potable water, free of oils, acids, alkalies, organic matter or other deleterious substances, meeting requirements of ASTM C94.

2.2 MIXING MATERIALS

- A. Thoroughly mix sand, cement and water in proportions of the mix design using a pugmill-type mixer. The plant shall be equipped with automatic weight controls to ensure correct mix proportions.

- B. Stamp batch ticket at plant with time of loading directly after mixing. Material not placed and compacted within 4 hours after mixing shall be rejected.

PART 3 –EXECUTION

3.1 PLACING

- A. Place sand-cement mixture in 8-inch-thick loose lifts and compact to 95 percent of ASTM D558, unless otherwise specified. The moisture content during compaction shall be on the dry side of optimum but sufficient for hydration. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at the plant.
- B. Do not place or compact sand-cement mixture in standing or free water.

3.2 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01410 - Testing Laboratory Services.
- B. Mixing plant inspections will be performed periodically. Material samples will be obtained and tested in accordance with Paragraph 2.1, Materials, if there is evidence of change in material characteristic.
- C. Random samples of delivered product will be taken in the field at point of delivery for each day of placement in a work area. Specimens will be prepared in accordance with ASTM C31 and tested for 48-hour compressive strength in accordance with ASTM D1633.
- D. The cement content will be checked on samples obtained in the field whenever there are apparent changes in the mix properties.

END OF SECTION

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SECTION 02501

DUCTILE IRON PIPE AND FITTINGS

PART 1 – G E N E R A L

1.1 SECTION INCLUDES

- A. Ductile iron pipe and fittings for water mains, pressure pipe, gravity sanitary sewers, and storm sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ANSI A 21.4 (AWWA C 104) - Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings, for Water and Other Liquids.
- B. ANSI A 21.10 (AWWA C 110) - Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in., for Water and Other Liquids.
- C. ANSI A 21.11 (AWWA C 111) - Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- D. ANSI A 21.15 (AWWA C 115) - Flanged Ductile-Iron Pipe with Threaded Flanges.
- E. ANSI A 21.50 (AWWA C 150) - Thickness Design of Ductile-Iron Pipe.
- F. ANSI A 21.51 (AWWA C 151) - Ductile-Iron Pipe, Centrifugally Cast for Water and Other Liquids.
- G. ANSI A 21.53 (AWWA C 153) - Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for water service.
- H. ANSI B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- I. ASTM D 1248 - Polyethylene Plastics Molding and Extrusion Materials.
- J. ASTM G 62 - Test Methods for Holiday Detection in Pipeline Coatings.
- K. AWWA C 600 - Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
- L. SSPC-SP 6 - Steel Structures Painting Council, Commercial Blast Cleaning.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01300 - Submittal Procedures.
- B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fitting, flange, and special details. Show station numbers for pipe and fittings corresponding to Drawings. Production of pipe and fittings prior to review by Owner is at Contractor's risk.

1.5 QUALITY CONTROL

- A. Provide manufacturer's certifications that all ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.
- B. Provide certifications that all pipe joints have been tested and meet requirements of ANSI A 21.11.

PART 2 – PRODUCTS**2.1 DUCTILE IRON PIPE**

- A. Ductile Iron Pipe Barrels: ANSI A 21.15, ANSI A 21.50 or ANSI A 21.51; bear mark of Underwriters' Laboratories approval; minimum thickness Class 51 for water mains and Class 52 for wastewater services, or as shown on Drawings. Provide minimum thickness Class 53 for flanged pipe.
- B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on shop drawings.

2.2 JOINTS

- A. Joint Types: ANSI A 21.11 push-on; ANSI A 21.11 mechanical joint; or ANSI A 21.15 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications. For bolted joints, bolts shall conform to requirements of AWWA C 111.
- B. Where restrained joints for buried service are required by Drawings, provide one of the following, or equal:
 - 1. Super-Lock Joint by Clow Corporation.
 - 2. Flex-Ring or Lok-Ring by American Cast Iron Pipe Company.
 - 3. TR-Flex Joint by U.S. Pipe and Foundry Company.
- C. Threaded- or grooved-type joints, which reduce pipe wall thickness below minimum required, are not acceptable.
- D. Where ductile iron water main is cathodically protected from corrosion, bond rubber gasketed joints as shown on Drawings to provide electrical continuity along entire pipeline, except where insulating flanges are required by Drawings.

2.3 GASKETS:

- A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material; for flanged joints 1/8-inch-thick gasket in accordance with ANSI A 21.15.
- B. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed pipeline, shall have the following gasket materials for the noted contaminants:

Contaminant	Gasket Material Required
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacture

2.4 FITTINGS

- A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they serve.
- B. Push-on Fittings: ANSI A 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.
- C. Flanged Fittings: ANSI A 21.10; ANSI B 16.1 cast or ductile iron. Flanges: ANSI B 16.1, Class 125; pressure rated at 250 psig.
- D. Mechanical Joint Fittings: ANSI A 21.11 (AWWA C 110); pressure rated at 250 psi.
- E. Ductile Iron Compact Fittings for Water Mains: ANSI A 21.53; 4-inch through 12-inch diameter; cement-mortar lining.

2.5 COATINGS AND LININGS

- A. Water Main Interiors: ANSI A21.4, cement lined with seal coat.
- B. Sanitary Sewer and Force Main Interiors:
 - 1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.
 - 2. Liner thickness: Nominal 40 mils, minimum 35 mils, for pipe barrel interior; minimum 6 to 10 mils at gasket groove and outside spigot end to 6-inches back from end.
 - 3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.
 - 4. Acceptable Lining Materials:
 - a. Virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage heat bonded to interior surface of pipe and fittings; "Polyline" by American Cast Iron Pipe Company; or equal.
 - b. Polyurethane: Corro-pipe II by Madison Chemicals.
 - c. Ceramic Epoxy: Protecto-401 by Enduron Protective Coatings.

- C. Exterior: Prime coat and outside asphaltic coating conforming to ANSI A 21.10, ANSI A 21.15, or ANSI A 21.51 for pipe and fittings in open cut excavation and in casings.
- D. Polyethylene Wrap: For buried water lines and sanitary sewers, including point repairs, provide polyethylene wrap unless otherwise specified or shown. Provide polyethylene wrap for buried ductile iron pipe, including polyurethane coated pipe.
- E. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners. Alternatively, provide bolts made of Type 304 stainless steel.

2.6 MANUFACTURERS

- A. Pre-approved manufacturers of ductile iron pipe are American Cast Iron Pipe Co., McWayne Cast Iron Pipe Co., and U. S. Pipe and Foundry Co.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conform to installation requirements of Section 02532 – Sanitary Sewage Force Main, except as modified in this Section.
- B. Install in accordance with AWWA C 600 and manufacturer's recommendations.
- C. Install all ductile iron pipe in polyethylene wrap, unless cathodic protection is provided. Do not use polyethylene wrap with a cathodic protection system.

3.2 GRADE

- A. Unless otherwise specified on Drawings, install ductile iron pipe for the service to clear utility lines with following minimum cover:

<u>Diameter (Inches)</u>	<u>Depth of Cover (Feet)</u>
16 and 24	5
12 and smaller	4

END OF SECTION

SECTION 02506

POLYVINYL CHLORIDE PIPE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Polyvinyl Chloride Pressure Pipe for force mains or gravity sewers in nominal diameters 4 inches through 36 inches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - I. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ANSI A21.5 (AWWA C 105) - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
- B. ANSI A21.10 (AWWA C 110) - Ductile-Iron and Gray-Iron Fittings, 3 inches through 48 inches for Water and Other Liquids.
- C. ANSI A21.11 (AWWA C 111) - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- D. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
- E. ASTM D 1784 - Standard Specification for Rigid Polyvinyl Chloride Compound and Chlorinated Polyvinyl Chloride Compounds.
- F. ASTM D 2241 - Standard Specification for Polyvinyl Chloride Plastic Pipe (SDR-PR).
- G. ASTM D 2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- H. ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- I. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Polyvinyl Chloride Composite Sewer Piping.
- J. ASTM D 3034 - Specification for Type PSM Polyvinyl Chloride Sewer Pipe and Fittings.
- K. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

- L. ASTM D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- M. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- N. ASTM F 679 - Specification for Polyvinyl Chloride Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- O. ASTM F 794 - Specification for Polyvinyl Chloride Large-Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- P. ASTM F 949 - Specification for Polyvinyl Chloride Corrugated Sewer Pipe with a Smooth Interior and Fittings.
- Q. AWWA C 900 - Polyvinyl Chloride Pressure Pipe, 4 Inches Through 12 Inches for Water Distribution.
- R. AWWA C 905 - Polyvinyl Chloride Water Transmission Pipe, Nominal Diameters 14 Inches Through 36 Inches.
- S. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
- T. UNI-B-11 - Recommended Standard Specification for Polyvinyl Chloride Water Transmission Pipe (Nominal Diameters 14 Inches through 36 Inches).
- U. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01300 - Submittal Procedures.
- B. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.5 QUALITY CONTROL

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C 900 or AWWA C 905 for pressure pipe applications, or the appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that PVC pressure pipe has been hydrostatically tested at the factory in accordance with AWWA C 900 or AWWA C 905 and this Section.
- C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Furnish copies of test reports to Owner for review. Cost of testing shall be borne by Contractor.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.
- C. For PVC pressure pipe used for force mains, provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
- D. Gaskets:

1. Gaskets shall meet the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.
2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

3. Do not use PVC gasket material for water mains in potentially contaminated areas.
- E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.
- F. PVC pipe for water service shall bear National Sanitation Foundation Seal of Approval (NSF-PW).

2.2 FORCE MAIN OR GRAVITY SEWER SERVICE PIPE

- A. Pipe 4-inch through 12-inch: Pipe shall be suitable for use at maximum hydrostatic working pressures of 200 psi at 73 F. All pipe must meet requirements as set forth in PS22.70 with standard dimension ratio SDR 21, and bearing the National Sanitation Foundation seal for potable water pipe. Provisions must be made for contraction &

expansion at each joint with a rubber ring, and integral thickened bell as part of each joint. nominal 20-foot lengths; cast-iron equivalent outside diameters.

- B. Joints: ASTM D 3139; push-on type joints in integral bell or separate sleeve couplings. Do not use socket type or solvent weld type joints.
- C. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by Owner.
- D. Hydrostatic Test: AWWA C 900, AWWA C 905, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification.

2.3 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A 21.10, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating. For PVC piping, use bends and fittings conforms to IPS dimensional.
- B. Coatings and Linings: Conform to requirements of Section 02501 - Ductile-Iron Pipe and Fittings.

2.4 FORCE MAIN PIPE

- A. Provide PVC pressure pipe conforming to the requirements for water service pipe, and conforming to the minimum working pressure rating specified in Section 02532 - Force Main.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.
- C. Fittings: Provide ductile iron fittings as per Paragraph 2.03, except furnish fittings with one of the following internal linings:
 - 1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".
 - 2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.
 - 3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.
- D. Exterior Protection: Provide polyethylene wrapping of ductile iron fittings as required by Section 02528 - Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.02E.
- F. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:

1. J-M Manufacturing Company, Inc.
2. CertainTeed Corporation
3. Diamond Plastics Corporation
4. Carlon Company

PART 3 - EXECUTION

3.1 PROTECTION

- A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.

3.2 INSTALLATION

- A. Conform to requirements of Section 02532 - Force Mains as applicable or Section 2531 – Gravity Sanitary Sewers.
- B. Install PVC pipe in accordance with Section 02317 - Excavation and Backfill for Utilities, ASTM D 2321, and manufacturer's recommendations.
- C. Force main service pipe 12 inches in diameter and smaller: Installed to clear utility lines and have minimum 3 feet of cover below grade, unless otherwise required by Drawings.
- D. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.
- E. Hand shovel pipe bedding under the pipe haunches and along the sides of the pipe barrel and compact to eliminate voids and ensure side support.

END OF SECTION

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SECTION 02513

TAPPING SLEEVE AND WET CONNECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Wet connections to existing piping.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. AWWA C 800 - Underground Service Line Valves and Fittings.

1.4 DEFINITIONS

- A. Wet connections consist of isolating sections of pipe to be connected with installed valves, draining the isolated sections, completing the connections and temporary plug for the existing line.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tapping sleeves shall be cast iron or ductile iron split sleeves. Each sleeve shall have a branch connection with a flange end. The inside diameter of each branch shall be oversized to permit entry and exit of tapping machine cutters. Each flange shall have a recess to center a tapping valve. Recesses shall meet the requirements of MSS SP-60. Flange dimensions and drilling shall meet the requirements of ANSI B16.1. The sleeve dimensions shall be such that the sleeves will not leak when installed on cast iron, ductile iron, or polyvinyl chloride pipe with outside diameters shown in AWWA Standards.
- B. Tapping sleeves for 4-inch through 16-inch pipe shall be mechanical joint type. Design and manufacture tapping sleeves for a working pressure of 200 psi.
- C. Tapping sleeves for 18-inch and larger pipe shall be mechanical joint type. Design and manufacture tapping sleeves for a working pressure of 150 psi
- D. Valves shall conform to city requirements as shown in plans.

PART 3 – EXECUTION

3.1 CONNECTION OPERATIONS

- A. Plan wet connections in such manner and at such hours as to least inconvenience plant staff. Notify the Owner at least 48 hours in advance of making connections.
- B. Do not operate valves on mains in use by Owner. The Owner will handle, at no cost to Contractor, operations involving opening and closing valves for wet connections.
- C. Conduct connection operations. Connection work shall progress without interruption the plant operation. Connect the temporary by-pass line and plug the main line. Operate by-pass line at least 48-hours before construction begins on the outfall structure.

END OF SECTION

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SECTION 02531

GRAVITY SANITARY SEWERS

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Gravity sanitary sewers and appurtenances, including cleanouts, stacks, and service connections.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.
- B. Submit proposed methods, equipment, materials and sequence of operations for sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Test Reports. Submit test reports as specified in Part 3 of this Section.

1.4 QUALITY CONTROL

- A. Qualifications. Install a sanitary sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Regulatory Requirements.
 - 1. Install sewer lines to meet the minimum separation distance from any potable water line, as required by the Design Criteria for Sewerage, Systems, Texas Administrative Code - Chapter 217.13, Appendix E. Make notification to the Owner if water lines are uncovered during sanitary sewer installation where the minimum separation cannot be maintained.
 - 2. Lay gravity sewer lines in straight alignment and grade as required by the Texas Natural Resources Conservation Commission, State of Texas.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Inspect pipe and fittings upon arrival of materials at the job site.
- B. Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear or free fall. Do not drag pipe and fittings along the ground. Do not roll pipe unrestrained from delivery trucks.
- C. Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around the outside barrel of pipe and fittings.

PART 2 –PRODUCTS

2.1 PIPE

- A. Piping materials for gravity sanitary sewers shall be of the sizes and types indicated on the Drawings or as specified.
- B. Unlined reinforced concrete pipe is not acceptable.

2.2 PIPE MATERIAL SCHEDULE

- A. Conform to requirements specified in the following Sections:
 - 1. Section 02501 - Ductile Iron Pipe and Fittings.
 - 2. Section 02506 - PVC Pipe.

2.3 APPURTENANCES

- A. Stacks. Provide stacks for service connections wherever the top of the sewer is 8 feet or more below the finished grade. Make stacks of the same material as the sanitary sewer and construct as shown on Drawings.
- B. Service Connections. For service connections conform to requirements of Section 02762 - Sanitary Sewer Service Reconnections. Provide a wye or tee at the points of connection shown on the Drawings.
- C. Roof, street or other type of surface water drains shall not be connected or reconnected into the sanitary sewer lines.

2.4 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill: Conform to requirements of Sections 02317 - Excavation, and Backfill for Utilities, and 02321 - Cement Stabilized Sand.
- B. Topsoil: Conform to requirements of Section 02922 - Topsoil.

PART 3 –EXECUTION

3.1 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation if construction will affect traffic.
- B. Provide barricades and flashing warning lights and signs for excavations. Maintain barricades and warning lights where work is in progress or where affected by the work.
- C. Perform work in accordance with OSHA standards. Employ a Trench Safety System as specified in Section 01561 - Trench Safety System for excavations over 5 feet deep.
- D. Immediately notify the agency or company owning any utility line which is damaged, broken or disturbed. Obtain approval from Owner and agency for any repairs or relocations, either temporary or permanent.

- E. Remove old pavements and structures including sidewalks and driveways in accordance with requirements of Section 02076 - Removing Existing Pavements and Structures.
- F. Install and operate dewatering and surface water control measures in accordance with Section 01563 - Control of Ground Water and Surface Water.
- G. Do not allow sand, debris or runoff to enter sewer system.

3.2 DIVERSION PUMPING

- A. Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from Owner.
- B. Design piping, joints and accessories to withstand twice the maximum system pressure or 50 psi, whichever is greater.
- C. No sewage shall be diverted into any area outside of the sanitary sewer.
- D. In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Promptly notify Owner so that required reporting can be made to the Texas Natural Resources Conservation Commission and the Environmental Protection Agency by the Owner.
- E. The cost of diversion pumping is included in base cost of point repair work.

3.3 EXCAVATION

- A. Earthwork. Refer to Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.
- B. Line and Grade. Establish the required uniform line and grade in the trench from stakes set by the Owner. Maintain this control for a minimum of 100 feet behind and ahead of the pipe-laying operation. Use appropriately sized grade boards, as necessary, which are substantially supported. Protect the boards and location stakes from damage or dislocation. Use of a laser beam equipment to establish and maintain proper line and grade of the work is also acceptable.
- C. Trench Excavation. Excavate pipe trenches to depths shown on Drawings and as specified in Section 02317 - Excavation and Backfill for Utilities.

3.4 PIPE INSTALLATION BY OPEN CUT

- A. Install pipe in accordance with the pipe manufacturer's recommendations and as specified in the following paragraphs.
- B. Install pipe only after excavation is completed, the bottom of the trench fine graded, bedding material is installed, and the trench has been approved by the Owner.
- C. Install pipe to the line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in the trench so the interior surfaces of the pipe follow the grades and alignment indicated. Provide bell holes where necessary.
- D. Install pipe with the spigot ends toward the direction of flow.
- E. Form a concentric joint with each section of adjoining pipe so as to prevent offsets.

- F. Keep the interior of pipe clean as the installation progresses. Where cleaning after laying the pipe is difficult because of small pipe size, use a suitable swab or drag in the pipe and pull it forward past each joint immediately after the joint has been completed. Remove foreign material and debris from the pipe.
- G. Provide lubricant, place and drive home newly laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Owner.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover the exposed ends of pipes with an approved plug to prevent foreign material from entering the pipe.
- J. Where the length of stubs is not indicated, install a 4-foot length and seal the free end with an approved plug.

3.5 INSPECTION AND TESTING

- A. Pipe Cleaning. For cleaning of existing sanitary sewers prior to pipe rehabilitation refer to Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Pipe Leakage Test. After backfilling a line segment and prior to tie-in of service connections, visually inspect gravity sanitary sewers where feasible, and test for leakage in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers..
- C. Deflection Testing. Use a Mandrel Test to test flexible pipe for deflection. Refer to Section 02533 - Acceptance Testing for Sanitary Sewers.
- D. Television Inspection. Prior to final acceptance of the line segment, perform closed circuit television inspection of newly constructed or rehabilitated sewers. Also perform preliminary video inspection of existing sanitary sewers to be rehabilitated. Refer to Section 02533 - Acceptance Testing for Sanitary Sewers.

3.6 BACKFILL AND SITE CLEANUP

- A. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Backfill the trench in specified lifts only after pipe installation is approved by the Owner.
- C. In unpaved commercial, industrial or undeveloped areas, grade surface at a uniform slope to natural grade as indicated on the Drawings. Provide a minimum of 4 inches of topsoil per Section 02911 - Topsoil and seed according to requirements of Section 02921 – Hydro-mulch Seeding.
- D. In unpaved residential areas, grade surface at a uniform slope to natural grade as indicated on the Drawings. Provide a minimum of 4 inches of topsoil per Section 02911 - Topsoil. Sod disturbed areas in accordance with Section 02922 - Sodding.

END OF SECTION

SECTION 02533

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 –GENERAL

1.1 SECTION INCLUDES

- A. Acceptance testing of sanitary sewers including:
 - 1. Visual inspection of sewer pipes
 - 2. Deflection testing for flexible sewer pipes.
 - 3. Leakage testing of sewer pipes.
 - 4. Leakage testing of manholes.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - 1. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM C828 - Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines.
- B. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
- C. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- D. UNI-B-3 - Recommended Standards for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe.
- E. 31 TAC 317.3 - Design Criteria for Sewage Systems.

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity flow sanitary sewers are required to have a straight alignment and uniform grade between manholes.
- B. Flexible pipe is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of a line segment but prior to final acceptance using a standard mandrel to verify that installed pipe is within specified deflection tolerances.

C. Maximum allowable leakage for Infiltration or Exfiltration

1. The total Exfiltration, as determined by a hydrostatic head test, shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of 2 feet above the crown of the pipe at the upstream manhole or 2 feet above the groundwater elevation, whichever is greater.
2. When pipes are installed more than 2 feet below the groundwater level, an infiltration test shall be used in lieu of the exfiltration test. The total infiltration shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours. Groundwater elevation must be at least 2 feet above the crown of the pipe at the upstream manhole.
3. Refer to Table 02533-2, Water Test Allowable Leakage, at the end of the Section, for measuring leakage in sewers. Perform leakage testing to verify that leakage criteria are met.

- D. Perform air testing in accordance with requirements of this Section and the Texas Natural Resources Conservation Commission requirements. Refer to Table 02533-3, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, and Table 02533-4, Minimum Testing Times for Low Pressure Air Test, at the end of this Section.

1.5 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.
- B. Test Plan: Before testing begins and in adequate time to obtain approval through the submittal process, prepare and submit a test plan for approval by Owner. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from the Drawings and Specifications.
- C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.6 GRAVITY SANITARY SEWER QUALITY ASSURANCE

- A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.
- B. Upon completion of tape reviews by Owner, Contractor will be notified regarding final acceptance of the sewer segment.

1.7 SEQUENCING AND SCHEDULING

- A. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at any one time.
- B. Coordinate testing schedules with Owner. Perform testing under observation of Owner.

PART 2 – PRODUCTS

2.1 DEFLECTION MANDREL

- A. Mandrel Sizing. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
- B. Mandrel Design. The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75 percent of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.
- C. Proving Ring. Furnish a "proving ring" with each mandrel. Fabricate the ring of 1/2-inch thick, 3-inch wide bar steel to a diameter 0.02-inches larger than approved mandrel deflection.
- D. Mandrel Dimensions (5% allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02533-1, Pipe vs. Mandrel Diameter, at the end of this Section. Mandrels for higher strength, thicker wall pipe may be used when approved by the Engineer.

2.2 EXFILTRATION TEST

- A. Water Meter: Obtain a transient water meter from the Owner for use when water for testing will be taken from the TDCJ system. Conform to Owner requirements for water meter use.
- B. Test Equipment:
 - 1. Pipe plugs.
 - 2. Pipe risers where the manhole cone is less than 2 feet above highest point in pipe or service lead.

2.3 INFILTRATION TEST

- A. Test Equipment:
 - 1. Calibrated 90 degree V-notch weir.
 - 2. Pipe plugs.

2.4 LOW PRESSURE AIR TEST

- A. Minimum Requirement for Equipment:
 - 1. Control panel.
 - 2. Low-pressure air supply connected to control panel.
 - 3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.

4. Air hoses from control panel to:
 - a. Air supply.
 - b. Pneumatic plugs.
 - c. Sealed line for pressuring.
 - d. Sealed line for monitoring internal pressure.

- B. Testing Pneumatic Plugs: Place a pneumatic plug in each end of a length of pipe on the ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable if they remain in place against the test pressure without external aids.

2.5 GROUND WATER DETERMINATION

- A. Equipment: Pipe probe or small diameter casing for ground water elevation determination.

2.6 SMOKE TESTING

- A. Equipment:
 1. Pneumatic plugs.
 2. Smoke generator as supplied by Superior Signal Company, or an approved equal.
 3. Blowers producing 2500 scfm minimum.

PART 3 –EXECUTION

3.1 PREPARATION

- A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.
- B. The selection of test methods and pressures for gravity sanitary sewers shall be determined based on ground water elevation.

3.2 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

- A. Check pipe alignment visually by flashing a light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.

3.3 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

- A. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of the line segment.
- B. Pull the approved mandrel by hand through sewer sections. Replace any section of sewer not passing the mandrel. Mandrel testing is not required for stubs.

- C. Retest repaired or replaced sewer sections.

3.4 LEAKAGE TESTING FOR GRAVITY SANITARY SEWERS

A. Test Options:

1. Test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
2. Test new or rehabilitated sanitary sewer manholes with water or low pressure air. Manholes tested with low pressure air shall undergo a physical inspection prior to testing.
3. Leakage testing shall be performed after backfilling of a line segment, and prior to tie-in of service connections.

B. Compensating for Ground Water Pressure:

1. Where ground water exists, install a pipe nipple at the same time sewer line is placed. Use a 1/2-inch capped pipe nipple approximately 10 inches long. Make the installation through manhole wall on top of the sewer line where line enters manhole.
2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect a clear plastic tube to nipple. Support tube vertically and allow water to rise in the tube. After water stops rising, measure height in feet of water over invert of the pipe. Divide this height by 2.3 feet/psi to determine the ground water pressure to be used in line testing.

C. Exfiltration test:

1. Determine ground water elevation.
2. Plug sewer in downstream manhole.
3. Plug incoming pipes in upstream manhole.
4. Install riser pipe in outgoing pipe of upstream manhole if highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.
5. Fill sewer pipe and manhole or pipe riser, if used, with water to a point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.
6. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over a one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure the quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to the table in Paragraph 3.5A.

- D. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).

1. Determine ground water elevation.
 2. Plug incoming pipes in upstream manhole.
 3. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.
 4. Allow water to rise and flow over weir until it stabilizes.
 5. Take five readings of accumulated volume over a period of 2 hours and use average for infiltration. The average must not exceed that calculated for 2 hours from allowable leakage according to the table in paragraph 3.5A.
- E. Low Air Pressure Test: When using this test conform to ASTM C828 and ASTM C924 with holding time not less than that listed in the attached table.
1. Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter.
 2. Lines 36-inch average inside diameter and larger shall be tested at each joint. The minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during a joint test shall be 10 seconds, regardless of pipe size.
 3. For pipe sections less than 36-inch average inside diameter:
 - a. Determine ground water level.
 - b. Plug both ends of pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug concrete pipe.
 - c. After a manhole-to-manhole section of sanitary sewer main has been sliplined and prior to any service lines being connected to new liner, plug liner at each manhole with pneumatic plugs.
 - d. Pressurize pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). See table in paragraph 3.5B.
 - e. To determine air loss, measure the time interval for pressure to drop to 2.5 psig. The time must exceed that listed in the table in paragraph 3.5B for pipe diameter and length. For sliplining, use diameter of carrier pipe.
- F. Retest: Any section of pipe which fails to meet requirements shall be repaired and retested.

3.5 TEST CRITERIA TABLES

- A. Exfiltration and Infiltration Water Tests: Refer to Table 02533-2, Water Test Allowable Leakage, at the end of this Section.
- B. Low Pressure Air Test:

1. Times in Table 02533-3, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, at the end of this Section, are based on the equation from State Design Criteria 317.2(a)(4)(B).

where:

- T = time for pressure to drop 1.0 pounds per square inch gauge in seconds
K = 0.000419 DL, but not less than 1.0
D = average inside diameter in inches
L = length of line of same pipe size in feet
Q = rate of loss, 0.0015 ft³/min./sq.ft. internal surface

2. Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter is given in Table 02533-4, Minimum Testing Times for Low Pressure Air Test.
 1. When two sizes of pipe are involved, the time shall be computed by the ratio of lengths involved.
 2. Lines with a 27-inch average inside diameter and larger may be air tested at each joint.
 3. Lines with an average inside diameter greater than 36 inches must be air tested for leakage at each joint.
 4. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing.
 5. For joint test, the pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum times allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

3.6 LEAKAGE TESTING FOR MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
- B. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs a minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged if lines entering manhole have not been backfilled.
- C. Vacuum testing:
 1. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to the recommended maximum inflation pressure; do not over-inflate.
 2. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for the time period specified in the following table:

3. If the drop in vacuum exceeds 1 inch mercury (Hg) over the specified time period tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

D. Hydrostatic Exfiltration Testing:

1. Hydrostatic exfiltration testing shall be performed as follows: all wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water and maintained full for at least one hour.
 - a. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.
2. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.7 SMOKE TEST PROCEDURE FOR POINT REPAIRS

A. Application: Perform smoke test to:

1. Locate points of line failure for point repair.
2. Determine if point repairs are properly made.
3. Determine if service connections have been reconnected to the rehabilitated sewer.
4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.

B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in a single manhole section at any one time. Keep the number of open excavations to a minimum.

C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than 2 days, nor more than 7 days, prior to proposed testing. Also give notice to Owner's Fire Departments 24 hours prior to actual smoke testing.

D. Isolate Section: Isolate the manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal the annular space at manhole for sliplined sections.

E. Smoke Introduction:

1. Operate equipment according to manufacturer's recommendation and as approved by Owner.
2. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for a minimum of 5 minutes.
3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor the tap/connection for smoke leaks. Note sources of leaks.

F. Repair and Retest: Repair and replace any taps or connections noted as leaking and then

retest. Taps and connections may be left exposed in only one manhole section at a time. If repair or replacement, testing or retesting, and backfilling of the excavation is not completed within one work day, properly barricade and cover each excavation as approved by Owner.

- G. Service Connections: On houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to the newly installed liner pipe, perform a dye test to confirm reconnection. Introduce dye into the service line through a plumbing fixture inside the structure or a sewer cleanout immediately outside the structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms a reconnection.

3.8 TESTING OF SANITARY SEWER FORCE MAINS

- A. After the pipe and appurtenance have been installed and before covering, test line and drain. Prevent damage to the Work or adjacent areas. Use clean water to perform tests.
- B. Owner may direct tests of relatively short sections of completed lines to minimize traffic problems or potential public hazards.
- C. Test pipe in the presence of Owner; conform to minimum requirements of 31 TAC 317.3.
- D. Test pipe at 25 psig or 1.5 times design pressure of the pipe, whichever is greater. Design pressure of the force main shall be the rated total dynamic head of the lift station pump.
- E. Test pipe at the required pressure for a minimum of 2 hours according to requirements of Uni-B-3.
- F. Maximum allowable leakage shall be as calculated by the following formula:
Where:
L = Leakage in gallons per hour.
S = Length of pipe in feet.
D = Inside diameter of pipe in inches.
P = Pressure in pounds per square inch.
- G. Correct defects, cracks, or leakage by replacement of defective items or by repairs as approved by Owner.
- H. Plug openings in the force main after testing and flushing. Use cast iron plugs or blind flanges to prevent debris from entering the tested pipeline.

**TABLE 02533-1
PIPE VS. MANDREL DIAMETER**

Nominal Material and Size <u>Wall Construction</u>	Average I.D. <u>(Inches)</u>	Diameter <u>(Inches)</u>	Minimum Mandrel <u>(Inches)</u>
PVC-Solid (SDR 26)	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Truss	12	11.790	11.201
	15	14.770	14.032
PVC-Profile	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
HDPE-Profile	48	47.500	45.125
	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
Fiberglass	54	54.000	51.300
	60	60.000	57.000
	12	12.65	12.018
	18	18.66	17.727
	20	20.68	19.646
	24	24.72	23.484
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
	48	48.76	46.322
	54	64.82	61.579
	60	60.38	57.361

**TABLE 02533-2
WATER TEST ALLOWABLE LEAKAGE**

DIAMETER OF RISER OR STACK in Inches	VOLUME PER INCH OF DEPTH		ALLOWABLE LEAKAGE*	
	Inch	Gallons	Pipe Size in Inches	Gallons/Minute per 100 Ft.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	10	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameter by value for 1" diameter.			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours.	

* Allowable leakage rate shall be reduced to 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within the 25-year flood plain.

**TABLE 02533-3
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST**

Pipe Diameter (inches)	Minimum Time (seconds)	Length For Minimum Time (feet)	Time For Longer Length (seconds)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)

24	1360	100	13.676 (L)
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TABLE 02533-4
VACUUM TEST TIME TABLE

VACUUM TEST TIME TABLE			
DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0
*Add T times for each additional 2-foot depth. (The values listed above have been extrapolated from ASTM C924-85)			

END OF SECTION

Section 02534

SANITARY SEWER SERVICE CONNECTIONS OR RECONNECTIONS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Installation of service connections in sanitary sewers serving areas where sanitary sewer service did not previously exist.
- B. Reconnection of existing service connections along parallel, replacement, or rehabilitated sanitary sewers.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

- 1. Payment for sanitary sewer service connections or service reconnections without stacks (standard) is on a unit price basis for each connection or reconnection. Payment will be made for each service connection or reconnection installed complete in place, including service connections, couplings, adapters disconnecting existing services, reconnecting new service, fittings, clean-outs, excavation, and backfill.
- 2. Payment for sanitary sewer service connections or service reconnections with stacks (deep-cut) is on a unit price basis for each connection or reconnection. Payment will be made for each service connection or reconnection installed complete in place, including service connections, couplings, adapters disconnecting existing services, reconnecting new service, fittings, clean-outs, excavation, and backfill.
- 3. One or more connections discharging into a common point are considered one service connection. The Contractor shall reconnect existing service connections with the approval of the Resident Project Representative. The Resident Project Representative may require connections to be relocated to avoid having more than one service connection per reconnection.
- 4. Protruding service connections which must be removed to allow liner insertion are paid as a service reconnection when connected. If abandoned, they will be paid as subsidiary to the service connection.
- 5. No separate payment will be made for abandonment of service connection. No separate payment will be made for excavation of sanitary sewer services within the new or replacement sewer trench. These services will be subsidiary to this item.
- 6. No separate payment will be made for removal of existing sanitary sewer service connections.
- 7. No separate payment will be made for an abandoned service connection.
- 8. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

**SANITARY SEWER CONNECTIONS
OR RECONNECTIONS**

- A. ASTM D 1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

1.04 PERFORMANCE REQUIREMENTS

- A. Accurately locate in the field all proposed service connections along the new sanitary sewer main.
- B. Accurately locate in the field existing service connections and proposed service connections along the alignment of the new parallel or replacement sewer main.
- C. Accurately locate existing system to be abandoned.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for each pipe product, fitting, coupling and adapter.
- C. Show reconnected services on record Drawings. Give the exact distance from each service connection to the nearest downstream manhole.

PART 2 PRODUCTS

2.01 PVC SERVICE CONNECTION

- A. Use PVC sewer pipe of 4-inch through 6-inch diameter, conforming to ASTM D 1784 and ASTM D 3034, with a cell classification of 12454-B. The SDR (ratio of diameter to wall thickness) shall be 35.
- B. PVC pipe shall be gasket jointed with gasket conforming to ASTM D 3212.
- C. Provide service connection pipe in sizes shown on the Drawings. For reconnection of existing services, select service connection pipe diameter to match existing service diameter. Reconnections to rehabilitated sanitary sewer mains shall be limited to the following maximum service connection diameter:

Sewer Diameter	Maximum Service Connection Diameter
8" or less	4"
10" or greater	6"

- D. Connect service pipes to new, parallel or replacement sewer mains with prefabricated, full-bodied wye fittings conforming to specifications for sewer main pipe material as specified in other Sections for sewers up to 18 inches in diameter.
- E. Where sewers are installed using pipe augering or tunneling, or where the sewer is greater than 18 inches in diameter, use Fowler "Inserta-Tee" to connect the service to sewer main.

2.02 PIPE SADDLES

- A. Use pipe saddles only on rehabilitated sanitary sewer mains. Comply with Paragraph 2.01D for new parallel and replacement sanitary sewer mains.

**SANITARY SEWER CONNECTIONS
OR RECONNECTIONS**

- B. Supply one-piece prefabricated saddle, either polyethylene or PVC, with neoprene gasket to accomplish a complete seal. Use a saddle fabricated to fit the outside diameter of the connecting pipe. The protruding lip of the saddle must be at least 5/8-inch long with grooves or ridges to retain the stainless steel band clamps.

- C. Use 1/2-inch stainless steel band clamps for securing saddles to liner pipe.

2.03 COUPLINGS AND ADAPTERS

- A. For connections between new PVC pipe connectionouts and existing service, 4- or 6-inch diameter, use a flexible adapter coupling consisting of a neoprene gasket and stainless steel shear rings with 1/2-inch stainless steel band clamps.
- B. For connections between new PVC pipe connectionout and new service, use rubber-gasketed adapter coupling.

2.04 STACKS

- A. Provide stacks for service connections wherever the crown of the sewer is 7 feet or more below finished grade at main.
- B. Construct stacks of the same material as the sanitary sewer and as shown on the Drawings.
- C. Provide stacks of the same nominal diameter at the sanitary service line.

2.05 PLUGS AND CAPS

- A. Seal the upstream end of unconnected sewer service connections with rubber gasketed plugs or caps of the same pipe type and size. Provide plugs or caps by GPK Products, Inc., or approved equal.

PART 3 EXECUTION

3.01 PERFORMANCE REQUIREMENTS

- A. Provide a minimum of 72 hours notice to customers whose sanitary sewer service will potentially be interrupted.
- B. Accurately field locate service connections, whether in service or not, along the rehabilitated sanitary sewer main. For new, parallel and replacement sewers, service connections may be located as pipe laying progresses from downstream to upstream.
- C. Properly disconnect existing connections from the sewer and reconnect to the rehabilitated liner, as described in this Section.
- D. Reconnect service connections unless directed otherwise by Resident Project Representative.
- E. Complete reconnection of service lines within 24 hours after cured-in-place liner installation and within 72 hours after disconnection for slip lining, parallel, or replacement sanitary sewer mains.
- F. Reconnect services on cured-in-place liner at 12 feet depth or less by the excavation method. The Resident Project Representative reserves the right to require service connections by excavation when a remote cut service connection damages the lines.
- G. Reconnection by the excavation method shall include the stack and fittings and required pipe length to reconnect service line.

3.02 PROTECTION

- A. Provide barricades, warning lights, and signs for excavations created for service connections. Conform to requirements of Section 01555 – Traffic Control and Regulation.
- B. Do not allow sand, debris, or runoff to enter sewer system.

3.03 PREPARATION

- A. Determine the existing sewer locations and number of existing service connections from closed-circuit television (CCTV) inspection tapes or from field survey. Accurately field locate existing service connections, whether in service or not. Use existing service locations to connect or reconnect service lines or liner.
- B. For rehabilitated sanitary sewer mains, allow liner to normalize to ambient temperature and recover from imposed stretch. For cured-in-place liners, verify that liner is completely cured.
- C. For new parallel and replacement sanitary sewer mains, complete testing and acceptance of downstream sewers as applicable. Provide for compliance with requirements of Paragraph 3.01E.

3.04 EXCAVATION AND BACKFILL

- A. Excavate in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Perform work in accordance with OSHA standards. Employ a Trench Safety System as specified in Section 01561 - Trench Safety System for excavations requiring trench safety.
- C. Install and operate necessary ground water and surface water control measures in accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.

3.05 RECONNECTION BY EXCAVATION METHOD

- A. Remove a portion of existing sanitary sewer main or carrier pipe to expose the liner pipe. Provide sufficient working space for installing a prefabricated pipe saddle.
- B. Carefully cut the liner pipe making a hole to accept the connection out protruding from the underside of the saddle.
- C. Strap on the saddle using a stainless steel band on each side of the saddle. Tighten the bands to produce a watertight seal of the saddle gasket to the liner pipe.
- D. Remove and replace cracked, offset, or leaking service line for up to the right-of-way line.
- E. Make up the connection between liner and service line using PVC sewer pipe and approved fittings and couplings.
- F. Encase the entire service connection in cement stabilized sand or Class "B" concrete as shown on Drawings.
- G. Test the service connections before backfilling.

3.06 RECONNECTION BY REMOTE METHOD

- A. Make service reconnections using remote-operated cutting tools on cured-in-place liners at depths greater than 12 feet.
- B. Employ method and equipment that restore the service connection capacity to not less than 90 percent of original capacity.

- C. Immediately open any missed connections and repair any holes drilled in error using a method approved by Resident Project Representative.

3.07 RECONNECTION ON NEW, PARALLEL OR REPLACEMENT SEGMENTS

- A. Install service connections on the sewer main.
- B. Remove and replace cracked, offset or leaking service line to the easement or right-of-way line.
- C. Make up the connection between the main and the existing service line using PVC sewer pipe and approved couplings, as shown on the Drawings.
- D. Test service connections before backfilling.
- E. Embed the service connection and service line as specified for the sanitary sewer main as shown on the Drawings. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities.

3.08 INSTALLATION OF NEW SERVICE CONNECTIONS

- A. Install service connections in accordance with the details shown on the Drawings. Provide the length necessary as best option or route determined in the field.
- B. Test service connections before backfilling.
- C. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities.

3.09 TESTING

- A. Test service reconnections and service connections. Follow applicable procedures given in Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Perform a post installation CCTV inspection as specified in Section 02531 - Gravity Sanitary Sewers to show locations of service connection.

3.10 CLEANUP

- A. Backfill the excavation as specified in Section 02317 - Excavation and Backfill for Utilities.
- B. Replace pavement or sidewalks removed or damaged by excavation in accordance with Section 02951 - Pavement Replacement for Utility Construction. In unpaved areas, bring surface to grade and slope surrounding the excavation. Replace a minimum of 4 inches of topsoil and seed according to requirements of Section 02921 - Hydromulch Seeding or Section 2922 - Sodding.

END OF SECTION

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Section 02535

NON-METALLIC UTILITY LINE MARKING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Furnishing and installation of utility marking tape capable of being detected electronically and marker posts, all in conjunction with backfill of non-metallic utility lines.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

- 1. No separate payment will be made for non-metallic utility line marking. Include the cost of such marking in related work.

- 2. Refer to Section 01270 - Measurement and Payment for Unit Price Procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for Work in this Section is included in the total Stipulated Price.

1.03 DEFINITIONS

- A. Non-metallic utility line. Pressure or gravity flow pipelines constructed predominantly of PVC, HDPE, Clay, or other non-ferrous materials.

1.04 REFERENCE STANDARDS

- A. ASTM D 2103 - Specification for Polyethylene Film and Sheeting

1.05 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Metalized tape shall be manufactured specifically for warning and identification of buried utility lines. Tapes shall be inert plastic specially formulated for prolonged use underground and shall be resistant to alkalis, acids and other destructive agents found in the soil. Tape shall be provided in rolls, 3-inch minimum width, color coded for intended service with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED [SEWER] [WATER] PIPELINE" or similar wording. Color code and letter coding shall be permanent, unaffected by moisture and other substances contained in trench backfill material.

B. Color Codes shall be as follows:

1. Water Pipeline: Blue
2. Sewer Pipeline (both gravity and pressure): Green

C. Buried warning, identification, and locator tape for use in trenches containing non-metallic water and sewer lines shall be 5.5-mil composition film containing one layer of metalized foil laminated between two layers of inert plastic film. Tape shall be detectable by cable locating equipment used to locate underground utility pipelines.

D. Drivable, Flexible, Composite Utility Marker: Shall be durable, reinforced composite posts manufactured specifically for warning and identification of buried utility lines. Posts shall be 3-1/2 inches minimum width and a minimum of 78 inches in length, color coded for intended service with a 3-inch wide warning and identification decal attached. Warning and identification shall be "CAUTION BURIED [SEWER] [WATER] PIPELINE" or similar wording. Code and letter coloring shall be permanent.

PART 3 EXECUTION

3.01 INSTALLATION OF BURIED WARNING, IDENTIFICATION, AND LOCATOR TAPE.

A. Install tape continuously in backfill directly over buried utility pipeline, 6 to 24 inches below finished grade. Terminate marked segment no farther than 3 feet from an accessory of the pipeline (manholes, cleanouts, valve boxes, etc.).

3.01 INSTALLATION OF DRIVABLE, FLEXIBLE, COMPOSITE UTILITY MARKERS.

A. Location: Install flexible, composite utility markers in unpaved / undeveloped areas, highway, railroad, fence crossings, changes in pipeline direction, and as directed by the Resident Project Representative.

B. Installation: Install in a true, vertical plane directly over or immediately adjacent (within 2 feet) to the utilities to which they relate. Posts shall be driven to provide an anchoring depth of 30 inches.

END OF SECTION

SECTION 02731

CONCRETE PAVING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Portland Cement Concrete Paving.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - I. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- B. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- C. ASTM A615 - Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.
- D. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- E. ASTM C33 - Standard Specifications for Concrete Aggregates.
- F. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- G. ASTM C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- H. ASTM C78 - Standard Test Method for Flexural Strength of Concrete.
- I. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
- J. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- K. ASTM C136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- L. ASTM C138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- M. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- N. ASTM C150 - Standard Specification for Portland Cement.

- O. ASTM C174 - Standard Test Method for Measuring Length of Drilled Concrete Cores.
- P. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- Q. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- R. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
- S. ASTM C618 - Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
- T. TxDOT Tex-203-F - Sand Equivalent Test for Fine Aggregate.
- U. TxDOT Tex-406-A - Loss by Decantation Test for Coarse Aggregate.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.
- B. Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.
- C. Submit manufacturer's description and characteristics for mixing equipment, and for traveling form paver, if proposed for use, for approval.
- D. Submit manufacturer's certificates giving properties of reinforcing steel. Provide specimens for testing when required by Owner.

1.5 HANDLING AND STORAGE

- A. Do not mix different classes of aggregate without written permission of Owner.
- B. Class of aggregate being used may be changed before or during Work with written permission of Owner. New class shall comply with specifications.
- C. Segregated aggregate will be rejected. Before using aggregate whose particles are separated by size, mix them uniformly to grading requirements.
- D. Aggregates mixed with dirt, weeds or foreign matter will be rejected.
- E. Do not dump or store aggregate in roadbed.

PART 2 –PRODUCTS

2.1 MATERIALS

- A. Portland Cement:
 - 1. Sample and test cement to verify compliance with Standards of ASTM C150, Type I or Type III.
 - 2. Bulk cement which meets referenced standards may be used if the method of handling is approved by the Engineer. When using bulk cement, provide satisfactory weighing devices.
 - 3. Fly ash which meets standards of ASTM C618 may be used as mineral fill if the method of

handling is approved by the Engineer.

- B. Water: Conform to requirements for water in ASTM C94.
- C. Coarse Aggregate: Crushed stone or gravel, or combination thereof, which is clean, hard, durable, conforms to requirements of ASTM C33, and has abrasion loss not more than 45 percent by weight when subjected to Los Angeles Abrasion Test (ASTM C131).

1. Maximum percentage by weight of deleterious substances shall not exceed following values:

Percent by Weight of Total

<u>Item</u>	<u>Sample Maximum</u>
Clay lumps and friable particles	3.0
Material finer than 75- μ m (No. 200) sieve:	
Concrete subject to abrasion	3.0*
All Other concrete	5.0*
Coal and lignite:	
Where surface appearance of concrete is of importance	0.5
All other concrete	1.0

- * In case of manufactured sand, if material finer than 75- μ m (No. 200) sieve consists of dust of fracture, essentially free from clay or shale, these limits may be increased to 5 and 7 percent, respectively.

2. Coarse aggregate (size 1-1/2 inch to No. 4 sieve) shall conform to requirements of ASTM C33. Gradation shall be within following limits when graded in accordance with ASTM C136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 1-3/4" sieve	0
Retained on 1-1/2" sieve	0 to 5
Retained on 3/4" sieve	30 to 65
Retained on 3/8" sieve	70 to 90
Retained on No. 4 sieve	95 to 100
Loss by Decantation Test	
*Method Tex-406-A	1.0 maximum

- * In case of aggregates made primarily from crushing of stone, if material finer than 200 sieve is dust of fracture essentially free from clay or shale as established by Part III of Tex-406-A, percent may be increased to 1.5.

- D. Fine Aggregate: Sand, manufactured sand, or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Fine aggregate for concrete shall conform to requirements of ASTM C33. Gradation shall be within following limits when graded in accordance with ASTM C136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 3/8" sieve	0
Retained on No. 4 sieve	0 to 5
Retained on No. 8 sieve	0 to 20
Retained on No. 16 sieve	15 to 50

Retained on No. 30 sieve	35 to 75
Retained on No. 50 sieve	65 to 90
Retained on No. 100 sieve	90 to 100
Retained on No. 200 sieve	97 to 100

1. When subjected to color test for organic impurities (ASTM C40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than 80, unless higher value is shown on Drawings.
- E. Mineral Filler: Class C fly ash of acceptable quality and meeting requirements of ASTM C618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, it shall be stored and inspected in accordance with ASTM C618. Fly ash shall not be used in amounts to exceed 30 percent by absolute volume of cementitious material in mix design. Cement content may be reduced if strength requirements can be met. Note: When fly ash is used, the term "cement" is defined as cement plus fly ash.
- F. Air Entraining Agent: Furnish an air entraining agent conforming to requirements of ASTM C260.
- G. Water Reducer: Water reducing admixture conforming to requirements of ASTM C494 may be used if required to improve the workability of concrete. Amount and type of such admixture shall be subject to approval by Engineer.
- H. Reinforcing Steel:
 1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A615, Grade 60. Store steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil or other injurious materials.
 2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.
 3. Provide wire fabric conforming to ASTM A82. Use fabric in which longitudinal and transverse wires have been electrically welded at points of intersection. Welds shall have sufficient strength not to be broken during handling or placing. Welding and fabrication of fabric sheets shall conform to ASTM A185.
- I. Fibrous Reinforcing: Not Applicable.

2.2 EQUIPMENT

- A. Equipment: Conform to requirements of ASTM C94.

2.3 MIXING

- A. Employ and pay certified testing laboratory to prepare mix designs. Flexural strength shall be as specified using test specimens prepared in accordance with ASTM C31 and tested in accordance with ASTM C78 (using simple beam with third-point loading). Contractor shall determine and measure batch quantity of each ingredient, including all water for batch designs and all concrete produced for Work. Mix shall conform to these specifications and other requirements indicated on Drawings.
- B. Mix design to produce concrete which will have flexural strength of 500 psi at 7 days and 600 psi at 28 days. When high-early-strength cement is used, it shall reach at least 550 psi at 7 days and 600 psi at 28 days. Slump of concrete shall be at least 1 inch, but no more than 4 inches, when tested in accordance with ASTM C143.

1. Concrete pavement shall contain at least 5-1/2 sacks (94 pounds per sack) of cement per by testing in accordance with ASTM C231.
2. Use retardant when temperature exceeds 90 degrees F. Proportion shall be as recommended cubic yard, with not more than 6.5 gallons of water, net, per sack of cement (water cement ratio maximum 0.57). Cement content shall be determined in accordance with ASTM C138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.
3. Coarse dry aggregate shall not exceed 85 percent of loose volume of concrete.
4. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be 4-1/2 percent plus or minus 1-1/2 percent. Air content shall be determined by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent.

PART 3 –EXECUTION

3.1 EXAMINATION

- A. Verify compacted base is ready to support imposed loads and meets compaction requirements.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.
- B. Remove subgrade that will not support loaded form. Replace and compact subgrade to required density.

3.3 EQUIPMENT

- A. Alternate equipment and methods, other than those required by this article, may be used provided the Contractor demonstrates that equal, or better, results will be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order.
- B. Subgrade Planer and Template:
 1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on Drawings. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it will remain on form at all times, and have such strength and rigidity that, under tests made by changing support from wheels to center, planer will not develop deflection of more than 1/8 inch. Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.
 2. Provide template for checking contour of subgrade. Template shall be long enough to rest upon side forms and have such strength and rigidity that, when supported at center, maximum deflection shall not exceed 1/8 inch. Fit template with accurately adjustable rods projecting downward at 1-foot intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.

- C. Machine Finisher: Provide a power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires if it operates on concrete pavement.
- D. Hand Finishing:
 - 1. Provide mechanical strike and tamping template 2 feet longer than width of pavement to be finished. Shape template to pavement section.
 - 2. Provide two bridges to ride on forms and span pavement for finishing expansion and dummy joints. Provide floats and necessary edging and finishing tools.
- E. Burlap Drag for Finishing Slab: Furnish four plies of 10-ounce burlap material fastened to bridge to form continuous strip of burlap full width of pavement. The 3-foot width of burlap material shall be in contact with pavement surface. Keep burlap drags clean and free of encrusted mortar.
- F. Vibrators: Furnish mechanically operated synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.
- G. Traveling Form Paver: Approved traveling form paver may be used in lieu of construction methods employing forms, consolidating, finishing and floating equipment. Requirements of this specification for subgrade, pavement tolerances, pavement depth, alignments, consolidation, finishing and workmanship shall be met. If traveling form paver does not provide concrete paving that meets the compaction, finish and tolerances requirements of this specification, its use shall be immediately discontinued when so ordered by Owner and conventional methods shall be used.
 - 1. Equip traveling paver with longitudinal transangular finishing float adjustable to crown and grade. Float shall be long enough to extend across pavement to side forms or edge of slab.
 - 2. Insure that continuous deposit of concrete can be made at paver to minimize starting and stopping. Use conventional means of paving locations inaccessible to traveling paver, or having horizontal or vertical curvature that traveling paver cannot negotiate.
 - 3. Where Drawings require tie bars for adjacent paving, securely tie and support bars to prevent displacement. Tie bars may be installed with approved mechanical bar inserter mounted on traveling-form paver. Replace any pavement in which tie bars assume final position other than that shown on Drawings, unless corrective alternates are authorized in writing by Owner.

3.4 FORMS

- A. Side Forms: Use metal forms of approved shape and section. Preferred depth of form shall be equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness is not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. All forms shall be approved by Owner. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200-foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide reasonable straight edge on concrete. Top of each form section, when

tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.

B. Form Setting:

1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations. Provide supply of forms that will be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by Owner.
2. Adjacent slabs may be used instead of forms, provided that concrete is well protected from possible damage by finishing equipment. These adjacent slabs shall not be used for forms until concrete has aged at least 7 days.

3.5 REINFORCING STEEL AND JOINT ASSEMBLIES

- A. Accurately place reinforcing steel and joint assemblies and position them securely as indicated on Drawings. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Place all reinforcing steel and secure to chairs.
- B. Place pavement joint assemblies at required locations and elevations, and rigidly secure all parts in required positions. Install dowel bars accurately in joint assemblies as shown, each parallel to pavement surface and to center line of pavement. Rigidly secure in required position to prevent displacement during placing and finishing of concrete. Accurately cut header boards, joint filler and other material used for forming joints to receive each dowel bar. Drill dowels into existing pavement, secure with epoxy, and provide paving headers, as required, to provide rigid pavement sections.

3.6 FIBROUS REINFORCING

- A. Do not use fibrous reinforcing to replace structural, load bearing or moment reinforcing steel.

3.7 PLACEMENT

- A. Place concrete only when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Concrete shall not be placed when temperature is below 40 degrees F and falling.
- B. Place concrete within 60 minutes of mixing. Remove and dispose of concrete not placed within this period.
- C. Concrete slump during placement shall be 1 to 4 inches, except when using traveling-form paver slump shall be maximum of 2 inches.
- D. Deposit concrete rapidly and continuously on subgrade or subbase in successive batches. Distribute concrete to required depth and for entire width of placement in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At end of day or in case of unavoidable interruption of more than 30 minutes, place transverse construction joint at point of stopping work. Remove and replace sections less than 10 feet long.

- E. Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

3.8 COMPACTION

- A. Consolidate the concrete using mechanical vibrators as specified herein. Extend a vibratory unit across the pavement, not quite touching side forms. Space individual vibrators at close enough intervals to vibrate and consolidate entire width of pavement uniformly. Mount mechanical vibrators to avoid contact with forms, reinforcement, transverse or longitudinal joints.
- B. Furnish enough hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not covered by mechanically controlled vibrators.

3.9 FINISHING

- A. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.
 - 1. Use transverse finishing machine to make at least two trips over each area. Make last trip continuous run of not less than 40 feet. After transverse screeding, use hand-operated longitudinal float to test and level surface to required grade.
 - 2. Hand finish with mechanical strike and tamping template as wide as pavement to be finished. Shape template to pavement section. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make at least two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.
- B. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.
- C. After completion of straightedge operation, make first pass of burlap drag as soon as construction operations permit and before water sheen has disappeared from surface. Follow with as many passes as required to produce desired texture depth. Permit no unnecessary delays between passes. Keep drag wet, clean and free from encrusted mortar during use.

3.10 JOINTS AND JOINT SEALING

- A. Conform to requirements of Section 02752.

3.11 CONCRETE CURING

- A. Conform to requirements of Section 03370.

3.12 TOLERANCES

- A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10-foot straightedge parallel to center of roadway to bridge any depressions and touch all high spots. Do not permit ordinates measured from face of straight edge to surface of pavement to exceed 1/16 inch per foot from nearest point of contact. Maximum ordinate with 10-foot straightedge shall not exceed 1/8 inch. Grind spots in excess of requirements of this paragraph to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

3.13 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01410 - Testing Laboratory Services.
- B. Flexural Strength Test Specimens: Four test specimens for flexural strength test will be made for each 150 cubic yards or less of pavement that is placed in one day. Two specimens will be tested at 7 days. For failed 7-day tests, remaining two specimens will be tested at 28 days. Specimens will be made, cured and tested in accordance with ASTM C78 (using simple beam with third point loading). Minimum flexural strength (modulus of rupture) shall be 500 pounds per square inch at 7 days and 600 pounds per square inch at 28 days.
- C. Yield test will be made in accordance with ASTM C138 for cement content per cubic yard of concrete. If such cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. Minimum of one 4-inch core will be taken at random locations per 1,000 feet per lane or 500 square yards of pavement to measure in-place depth. Each core may be tested for 28-day compressive strength according to methods of ASTM C42. The 28-day compressive strength of each core tested shall be a minimum of 3000 pounds per square inch. Compressive strength shall not be utilized to satisfy the flexural strength requirements.
- E. Contractor may, at his own expense, request three additional cores in vicinity of cores indicating nonconforming in-place depths. In-place depth at these locations shall be average depth of four cores.
- F. Fill cores and density test sections with new concrete paving or non shrink grout.

3.14 NONCONFORMING PAVEMENT

- A. Remove and replace areas of pavement found deficient in thickness by more than 10 percent, or that fail flexural strength tests, with concrete of thickness shown on Drawings unless accepted by Owner.
- B. Nonconforming pavement sections shall be replaced at no cost to Owner.

3.15 UNIT PRICE ADJUSTMENT

- A. Unit price adjustments shall be made for in-place depth determined by cores as follows:
 - 1. Adjusted Unit Price shall be ratio of average thickness as determined by cores to thickness bid upon, times unit price bid.
 - 2. Adjustment shall apply to lower limit of 90 percent and upper limit of 105 percent of unit price bid.

3.16 PAVEMENT MARKINGS

- A. Restore pavement markings to match those existing in accordance with Owner's standard specifications and details and the Engineer's requirements.

3.17 PROTECTION

- A. Barricade pavement section from use until concrete has attained minimum design strength.

- B. To provide access at driveways, street intersections, and other locations approved by Owner; Contractor may use high-early-strength cement or place an additional 2 inches of concrete pavement on untreated subgrade in lieu of specified concrete pavement depth on stabilized base or lime treated subgrade. Additional depths of concrete placement shall be paid for under original specified concrete depth.
- C. On those sections of pavement to be opened to traffic, seal joints, clean pavement and place earth against pavement edges before permitting use by traffic. Such opening of pavement to traffic shall not relieve Contractor from his responsibility for Work.
- D. Maintain concrete paving in good condition until completion of Work.
- E. Repair defects by replacing concrete to full depth.

END OF SECTION

Section 02754

CONCRETE DRIVEWAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Portland cement concrete driveways.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for concrete driveways is on square yard basis.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for welded wire fabric of Section 02751 - Concrete Paving.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Subgrade Materials: Conform to subgrade material requirements of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, or Section 02338 - Portland Cement Stabilized Subgrade.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and Section 02338 - Portland Cement Stabilized Subgrade.

3.02 PLACEMENT

- A. Place and finish concrete in accordance with applicable portions of Section 02751 - Concrete Paving.

3.03 JOINTS

- A. Install joints in concrete driveway in accordance with Section 02752 - Concrete Pavement Joints.

3.04 CONCRETE CURING

- A. Cure concrete driveway in accordance with Section 02753 - Concrete Pavement Curing.

3.05 PROTECTION

- A. Conform to applicable requirements of Section 02753 - Concrete Pavement Curing.

END OF SECTION

SECTION 02775

CONCRETE SIDEWALKS

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Reinforced concrete sidewalks.

1.2 MEASUREMENT AND PAYMENT

- A. Unit prices.
 - I. Refer to Section 01200 – Measurement and Payment, for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM D698 - Standard Test Methods for Moisture - Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-Pound Rammer and 12-inch Drop.
- B. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 - Submittals.

PART 2 –PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02731 - Concrete Paving.
- B. Reinforcing steel: Conform to material requirements for welded wire fabric of Section 02731 - Concrete Paving.
- C. Preformed expansion joint material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Paving Joints.
- D. Expansion joint filler: Conform to material requirements for expansion joint material of Section 02752 – Concrete Paving Joints.
- E. Sand bed: Conform to material requirements for bank run sand of Section 02320 – Utility Backfill Materials.

PART 3 –EXECUTION

3.1 REPLACEMENT

- A. Replace sidewalks which are removed or damaged during construction with sidewalk of thickness and width equivalent to one removed or damaged.

- B. Provide replaced and new sidewalks with wheelchair ramps if sidewalk intersects curb at street or driveway intersection.

3.2 PREPARATION

- A. Identify and protect utilities which are to remain.
- B. Protect living trees, other plant growth, and features designated to remain.
- C. Clear and grub area.
- D. Excavate subgrade 6 inches beyond outside lines of sidewalk. Shape to the line, grade and cross section. For soils with plasticity index above 40 percent, stabilize soil with lime. Compact subgrade to minimum of 95 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D698.
- E. Immediately after subgrade is prepared, cover with 2-inch-thick compacted sand bed. Lay concrete when sand is moist but not saturated.

3.3 PLACEMENT

- A. Forms: Straight, unwarped wood or metal forms with nominal 4-inch depth. Securely stake forms to line and grade, and maintain in true position during concrete placement.
- B. Reinforcement: Install 6x6, W2.9 x W2.9 welded wire fabric or No. 3 reinforcing steel bars on 18-inch centers longitudinally and transversely. Lay longitudinal bars in walk continuously, except through expansion joints. Support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.
- C. Expansion Joints: Install expansion joints in accordance with Section 02752.
- D. Colored concrete: Not Applicable.
- E. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp, or other acceptable method. Bring mortar to surface.
- F. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush.
- G. Unless otherwise indicated on Drawings, mark off joints 1/8 inch deep, at spacing equal to width of walk. Use joint tool equal in width to edging tool.
- H. Finish edges with tool having 1/4-inch radius.
- I. After concrete has set sufficiently, refill space along sides of sidewalk to top of walk with suitable material. Tamp unit firm and solid. Dispose of excess material in accordance with Section 01564.

3.4 CURING

- A. Conform to requirements of Section 03370.

3.5 PROTECTION

- A. Maintain sidewalks in good condition until completion of Work.
- B. Replace damaged sidewalks in accordance with the Paragraph in this Section on REPLACEMENT.

END OF SECTION

Section 02911

TOPSOIL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and placing topsoil for finish grading and for seeding, sodding, and planting.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for topsoil under this Section, payment will be subsidiary to item 02534 Sewer Connections.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Topsoil shall be fertile, friable, natural sandy loam surface soil obtained from excavation or borrow operations having the following characteristics:

1. pH value of between 5.5 and 6.5
2. Liquid limit: 50 or less
3. Plasticity index: 20 or less.
4. Gradation: maximum of 10 percent passing the No. 200 sieve.

- B. Topsoil shall be reasonably free of subsoil, clay lumps, weeds, non-soil materials, and other litter or contamination. Topsoil shall not contain roots, stumps, and stones larger than 2 inches.

- C. Obtain topsoil from naturally well-drained areas where topsoil occurs at a minimum depth of 4 inches and has similar characteristics to that found at the placement site. Do not obtain topsoil from areas infected with a growth of, or reproductive parts of nut grass or other noxious weeds.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavation and embankment operations have been completed to correct lines and grades.

3.02 TOPSOIL EXCAVATION

- A. Strip off topsoil from the area to be excavated to a minimum depth of 6-inches, unless indicated otherwise on the Drawings.
- B. Place Topsoil in stockpile for reuse. Cover stockpile to prevent erosion.

3.03 PLACEMENT

- A. For areas to be seeded or sodded, scarify or plow existing material to a minimum depth of 4 inches, or as indicated on the Drawings. Remove vegetation and foreign inorganic material. Place 4 inches of topsoil on loosened material and roll lightly with an appropriate lawn roller to consolidate topsoil.
- B. Increase depth of topsoil to 6 inches when placed over sand bedding and backfill materials specified in Section 02320 - Utility Backfill Material.
- C. For areas to receive shrubs or trees, excavate existing material and place topsoil to the depth and dimensions shown on the Drawings.
- D. Remove spilled topsoil from curbs, gutters, and, paved areas and dispose of excess topsoil in accordance with requirements of Section 01576 - Waste Material Disposal.

3.04 PROTECTION

- A. Protect topsoil from wind and water erosion until planting is completed.

END OF SECTION

Section 02951

PAVEMENT REPLACEMENT FOR UTILITY CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Repairing and resurfacing streets, highways, driveways, sidewalks, and other pavements that have been cut, broken, or otherwise damaged during construction.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. Payment for pavement replacement for utility construction will be subsidiary to item 02534 Sewer Connections. Payment for item 02534 will be full compensation for saw cutting, backfill compaction, base material, surface material and all incidentals required for a complete installation as shown on the Drawings.
- 2. Refer to Section 01270 - Measurement and Payment for other unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Base: Provide base material as indicated on the Drawings.
- B. Pavement: Provide paving materials as required by applicable portions of Section 02741 - Asphaltic Concrete Pavement, Section 02751- Concrete Paving, Section 02754 - Concrete Driveways, and Section 02771 - Curb, Curb and Gutter, and Headers, and Section 02775 - Concrete Sidewalks.

PART 3 EXECUTION

3.01 PREPARATION

- A. Saw cut pavement 24 inches wider than width of trench needed to install utilities unless otherwise indicated on Drawings.
- B. Protect edges of existing pavement to remain from damage during removals, utility placement, backfill, and paving operations. For concrete pavement, leave and protect minimum of 12 inches of undisturbed subgrade on each side of trench to support replacement slab.

3.02 INSTALLATION

- A. Parking Areas, Service Drives, Driveways, and Sidewalks: Replace with material equal to or better than existing or as indicated on Drawings. Conform to applicable requirements of sections referenced in Paragraph 2.01, Materials.
- B. Street Pavements and Curbs, Curbs and Gutters: Replace subgrade, base, and surface course with like materials or as indicated on Drawings. Curbs and curbs and gutters shall match existing. Conform to requirements of sections referenced in Paragraph 2.01, Materials.

- C. For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on Drawings. Place types and spacing of joints to match existing or as indicated on Drawings.
- D. Repair State highway crossing in accordance with TxDOT permit and within 1 week after utility work is installed.

3.03 WASTE MATERIAL DISPOSAL

- A. Dispose of waste material in accordance with requirements of Section 01576 - Waste Material Disposal.

3.04 PROTECTION

- A. Maintain pavement in good condition until completion of the Work.
- B. Replace damaged pavement.

END OF SECTION